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# Whole Earth

Access to Tools, Ideas, and Practices SUMMER 1998

modern  
landscape  
ecology

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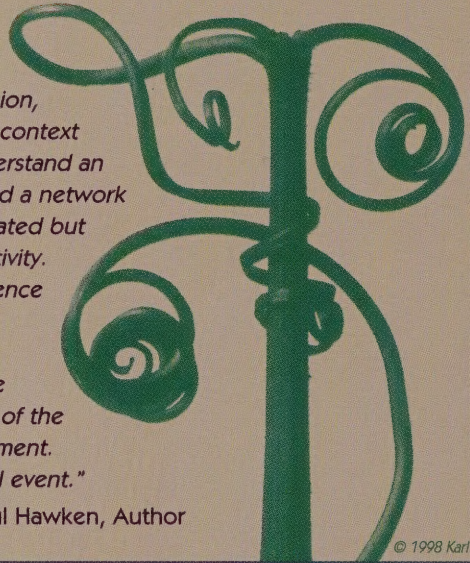
# the BIONEERS

VISIONARY SOLUTIONS FOR RESTORING THE EARTH

OCTOBER 23-25, 1998 • FORT MASON CENTER, SAN FRANCISCO

*"Occasionally a conference can, by the strength of its vision, create a whole new context within which to understand an issue. It can also build a network among people in related but separate fields of activity. The Bioneers Conference achieves all this, and more — being there changes the way one views the landscape of the environmental movement. It is a truly wonderful event."*

-Paul Hawken, Author



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Since 1990 the Bioneers Conference has assembled a gathering of visionaries with both feet on the ground to share strategies for restoration. The Bioneers are biological pioneers using nature to heal nature, helping define the coming Age of Biology based on natural principles of kinship, interdependence, cooperation, and community. They are the pilot fish guiding society to a future environment of hope. Their visionary work suggests that technical solutions alone will not restore the earth without a change of heart.

The annual Bioneers Conference brings together leading scientific and social visionaries who have developed both practical and visionary solutions for restoring the Earth. This inspired event has helped galvanize many brilliant practitioners into a thriving culture while equipping participants with models, resources and a community to support their participation in the work. The optimistic Bioneer vision is empowering individuals, companies, governments, and communities to become a primary force in the fabric of restoration.

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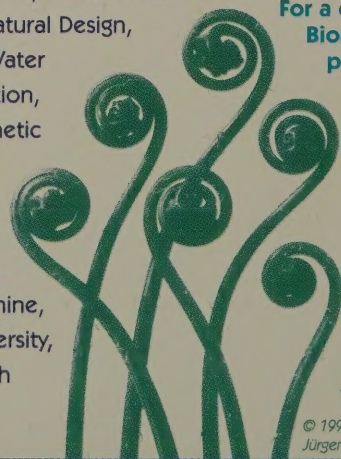
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# Modern Landscape Ecology

Whole Earth

Summer 1998

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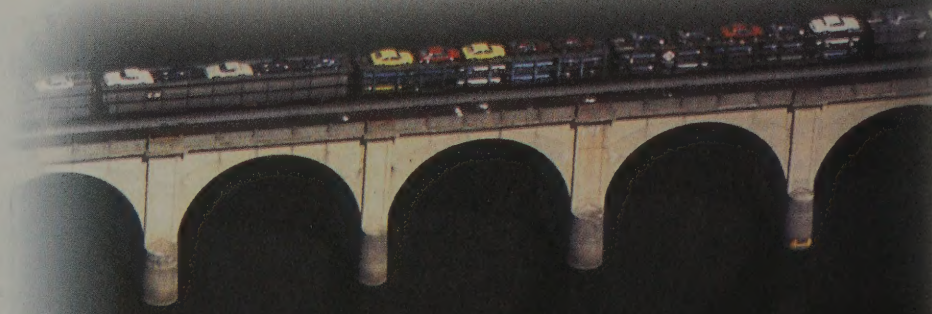
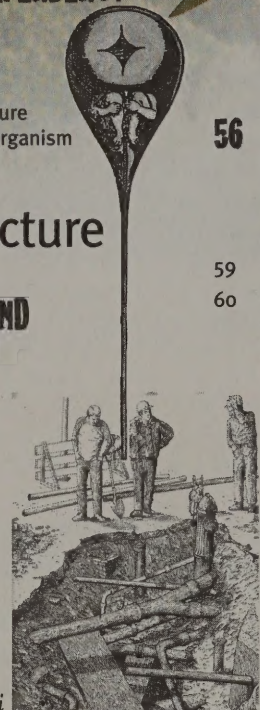
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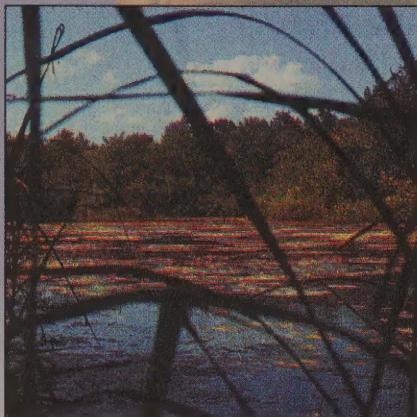


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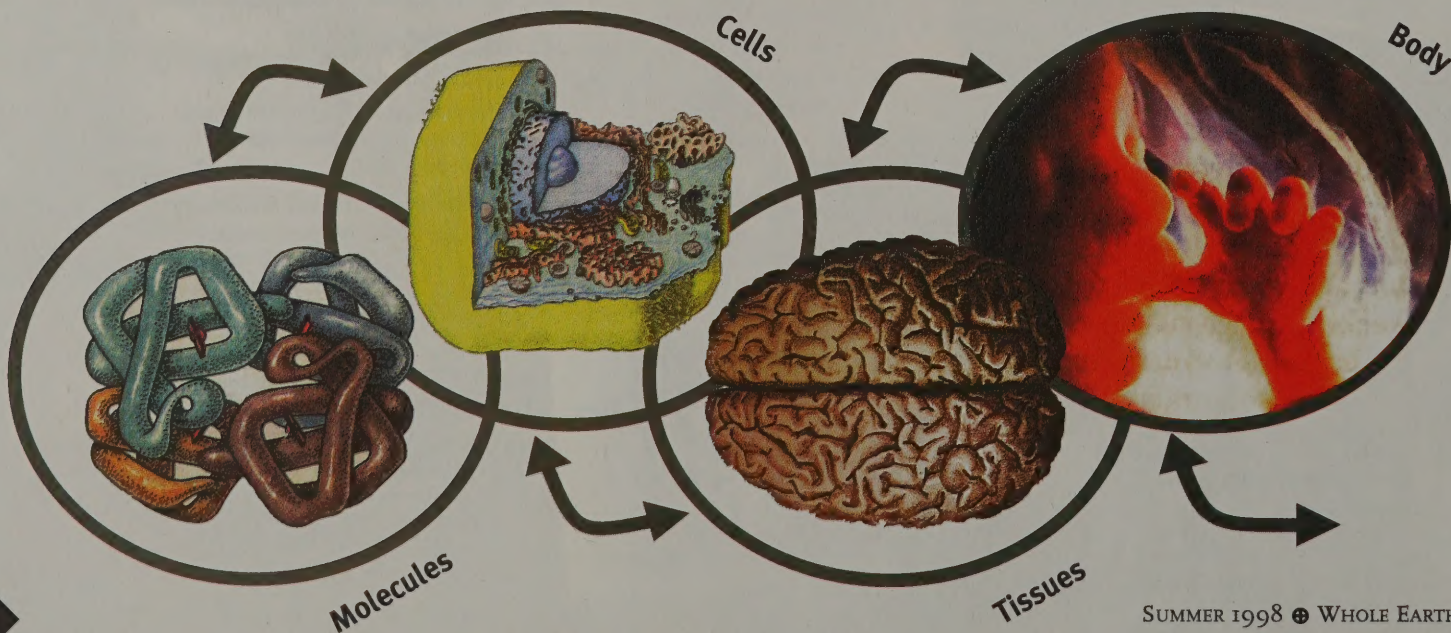




# MODERN LANDSCAPE ECOLOGY

Patterns of Infrastructure  
Patterns of Ecostructure  
Visions of a Gentler Way

**Peter Warshall**  
Drawings by Malcolm Wells



In earlier times, swallows, sea turtles, and salmon were messengers from unknown landscapes. Each year, they arrived like clockwork, and where they had come from was filled with myth and mystery. Now, humans have charted the planet's land, sea, and skyscapes. The old stories seem more childlike and the bards strive to rewrite Aesop's Fables for our times.

Whole Earth proposes an innovative way of viewing the landscapes of the world. The package includes a vocabulary that works for all kinds of

landscapes: natural, farmed, suburban, and urban; land, ocean, or sky. Even more daring, it may work for all size "-scapes," from cellular to body to watershed to ecoregion to

biosphere. Many citizens—civil engineers, construction workers, architects, commercial farmers, development experts, business strategists, staffs of government agencies and organized religions—work on projects that now spread out all over the planet. Our hope is to help bridge the gap between them and the citizens dedicated to conservation, industrial ecology, environmental health, and the rubric called sustainability.



The two contrasting, but not mutually exclusive, words that underpin this issue of Whole Earth are infrastructure and ecostructure. "Infrastructure" is a predominantly human-built collective of parts of any undertaking, arrayed over a landscape. Railroads were the first great industrial infrastructure, with their tracks, bedding, switches, tunnels, bridges, and stations. Public waterworks link watersheds, dams, treatment facilities, pipes, and sewage facilities. The infrastructure of our justice system includes law offices, courts, police stations, cars, and jails.

Infrastructures are always involved in flows, be it the flow of military personnel and equipment, energy (electricity, oil, information), minerals, petroleum, water, passengers, or other stuff all over the planet, and even off it.

Infrastructures help make health and financial services, environmental management, religion, even population control, reliable. Humans have shaped infrastructure to maximize growth, development, and, at times, conquest. Infrastructures are born and survive by human will. We rarely think about them. Maybe they flash by while we're looking for an electric plug outlet or in a stopped elevator during a major power blackout or, over coffee, speculating on what will happen if the world's computers do crash on January 1, 2000. To most of us, the life support given by infrastructures remains crucial but vague.

Biology, the life sciences, has never had a word to parallel infrastructure. Yet the natural world is composed of collections of parts that spread far and wide across landscapes. The flows of migrating birds cover continents, requiring a very specific configuration of nesting sites, staging areas for fueling and flight, areas for overwintering, and a reliable pattern of stars for orientation in transit. The circling flow



of salmon requires thousands of miles of water, composed of qualities ranging from salt to freshet, starting from the forest architecture of the birth stream, a clear undammed passage to and from an estuary, and well-defined currents and upwellings to hunt at sea. These arrays of connected parts govern the egg-works of

both birds and salmon, paralleling the waterworks or watt-works of infrastructure. We have cobbled together a new word—"ecostructure"—to emphasize that all nature's creatures, and most natural processes (not just those of humans), build and web structures. They have done it for a far longer time than human history.

Here's the scoop. To describe how humans and other creatures, and the grand forces of weather, embed themselves in landscapes, let four words enter your thoughts and speech and minds. They are easier to remember because they all start with the letter C. *Composition* of each governing part; *Configuration* of the parts; *Connectivity* between the parts; and *Community*, a boundary defined by geography.

### The Clash

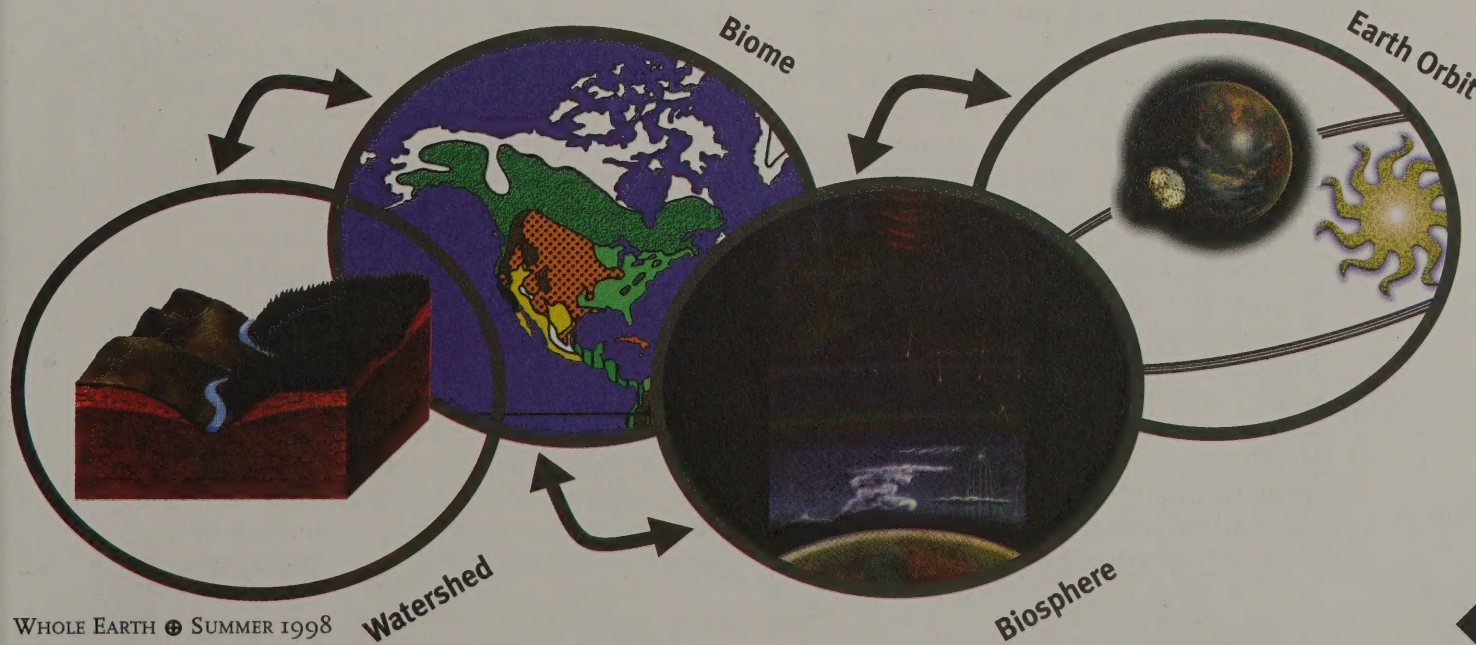
Infrastructure and ecostructure clash because the infrastructures designed by humans divulge overly narrow goals. Humans design infrastructure to benefit only ourselves and, at times, to harm each other. Hitler's dream of infrastructure included the facilities, equipment, train tracks, and installations for the perfection of genocide. The vast majority of infrastructures, however, are intended to insure more reliable flows of energy, water,

*continued on page 8*

and well-defined currents and upwellings to hunt at sea. These arrays of connected parts govern the egg-works of

The rabbit warren and the human-built tunnel are parallel elements in animal movement: the rabbit's ecostructure and the human's infrastructure.

Both eco- and infrastructures come in all sizes. Eco- or bio-structures start with the nucleic acid building blocks of DNA/RNA, structures which dwell in the nucleolus of the cell. The cell itself is a bounded colloidal structure dwelling in tissues. Tissues are the components of organs which are, in turn, the components of organisms who dwell in well-defined watersheds embedded in ecoregions which are the ecostructures of the biosphere.





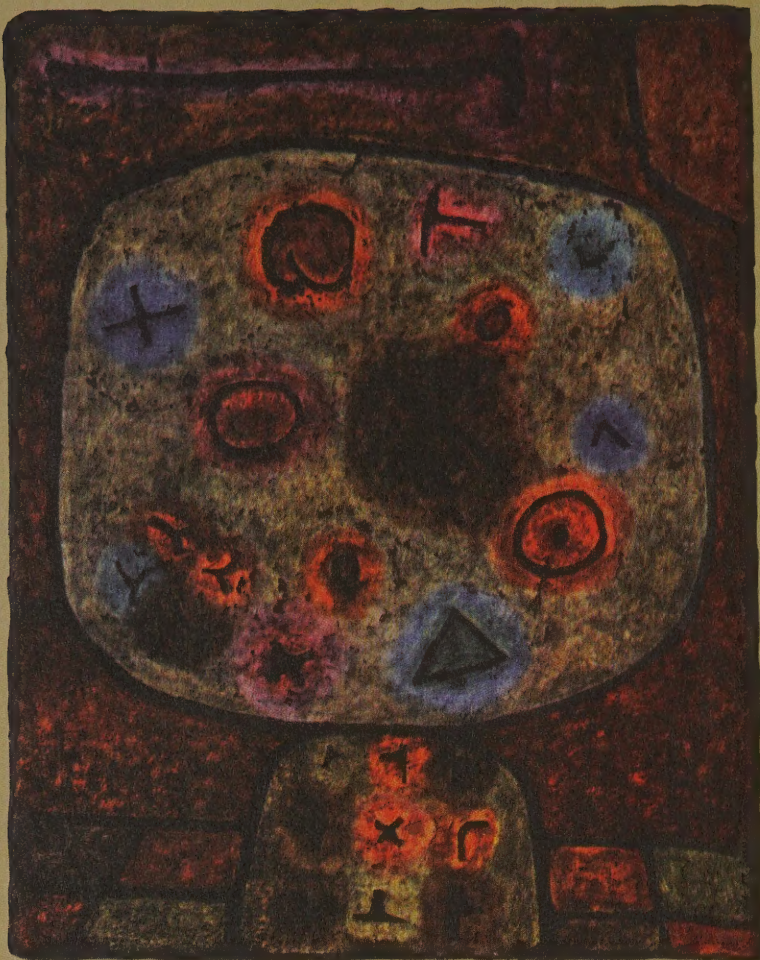
# Art as Landscape

## Flowers in Stone

Paul Klee

1939, Oil on Cardboard

19 5/8 in. x 15 5/8 in.



Contrast



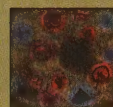
Context



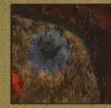
Boundary Form



Patch Size



Patch Configuration



Connectivity



Patch Orientation

Until the 1970s landscapes were more often associated with painting than ecology. Oddly, this idea—landscape as art—continued after most twentieth century painters had long abandoned painting hills and fields. Picasso once joked that he needn't paint landscapes, nature did a better job. Even more oddly, thirty years ago a few ecologists began adopting the concepts of the modernist art period to help them describe landscapes and seascapes and big-sized environments.

Landscape ecology and modern art were born from similar desires: to accurately describe the richness and beauty we all perceive; to paint or model the configuration, the array of lines and patches of colors and textures, the surprising events, and the overall evenness or fragmentation of the canvas or watershed as a whole. There are, for instance, "hard edge" paintings like those of Frank Stella and Piet Mondrian, and hard edge landscapes such as an array of large boulders scattered in a meadow or a ski resort condominium complex butting up on an old-growth forest; and "soft edge" paintings, like Mark Rothko's, and soft edge landscapes like the mosaicked transitions among freshwater, estuary, and saltwater marshes. Both disciplines love contemplating the contrasts between edges and patches.

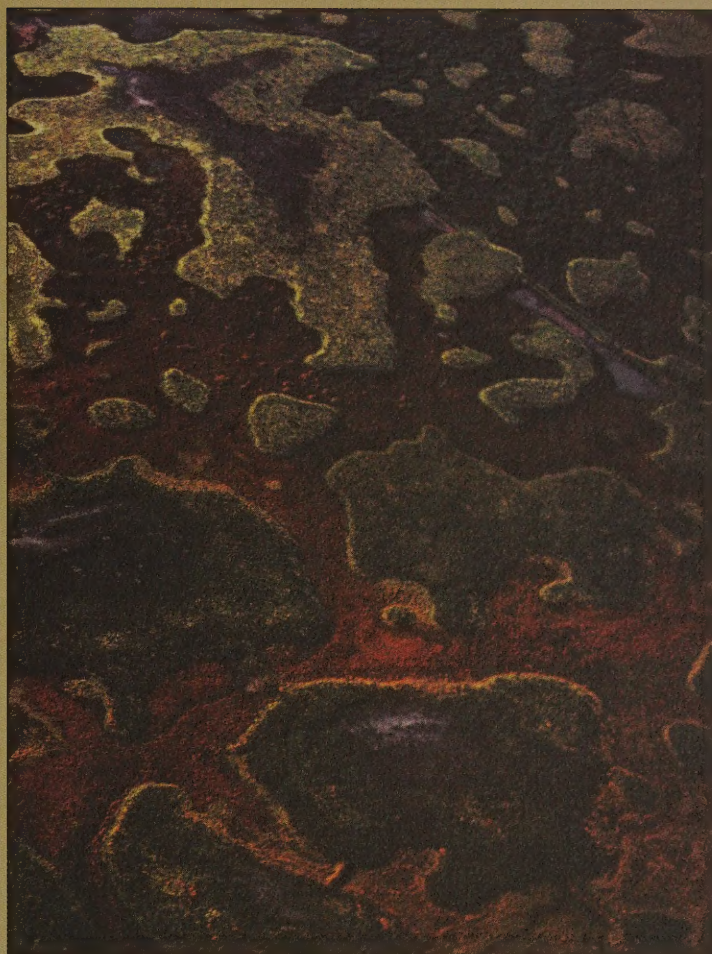
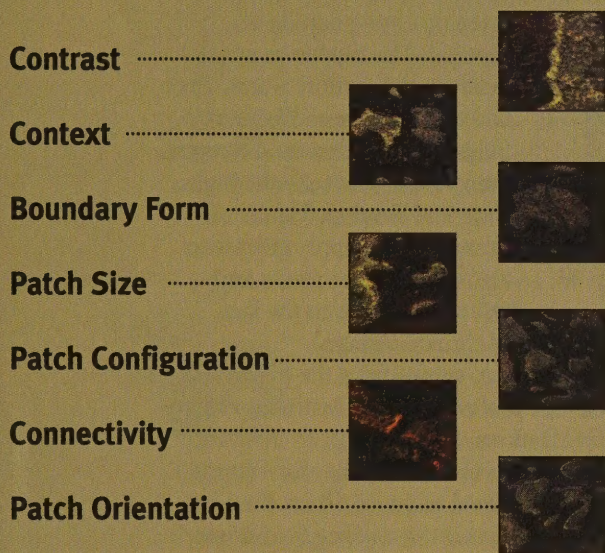
Parallels go much further. Henri Matisse (in his cutout phase), Gustav Klimt, and Paul Klee experimented tirelessly with configurations of patches of color: different sizes, the shape of each patch, the orientation of "floating" patches with the canvas's straight edges and with other patches inside the artwork's boundaries. Landscape ecologists similarly ponder patches such as beaver ponds in a watershed or forest groves dotted among evenly textured farmlands. The "right" configuration can bring harmony to either canvas or landscape. To conservation biologists, for instance, the size and shape of a patch of forest may mean the difference between protection of a rare warbler's home or nest parasitism by cowbirds. Informed intuition serves both painters and naturalists well.

The boundaries of the canvas have always bothered painters. One solution was the heavy gold frame. But modern artists rebelled against this over-defining box. They encouraged museums and galleries to paint their walls white and to use baby-spot lighting. Then they played with the canvas's boundary by painting its edge as white as the wall. White-on-white can meld the canvas into the greater art world architecture. Ecologists rarely find heavily framed environments (except for the cherished discovery of isolated islands and caves, where learning



# Landscape as Art

Sink Swamp, Fairfield, Utah  
Georg Gerster  
1990, Color Photograph



about life is so much easier without all those foreign intrusions). For a long time, the desire for simplicity has led ecologists to build a mental equivalent of heavy frames. They lay out a rectangular metric grid, study everything inside it, and ignore or downplay all “outside” influences. Contemporary landscape ecology, however, has in part rebelled. An “edge” for one creature may not mean much to another.

Impressionists pioneered another insight. If you surround one color with different ones, the internal color changes brightness or hue. The eye registers the internal color differently depending on the context. Such subtle and elegant perceptions also apply to patches of landscape. Surround one mountain by a valley of desert and a similar mountain by roaring rivers, and each mountain is slightly altered. The microclimates of the river and desert “color” the landscape with grit or mist, dust-born nutrients, or wind-blown humidity, a soft or a hard edge. Modern art has taught ecologists to pay close attention to the surround.

Step back from a canvas or fly over the landscape in a low-altitude airplane and still other qualities become vivid: repeating patterns, evenness of textures (be it white paint or forest or urban sprawl), and surprise elements (a splash of red or a monadnock jutting from a glacial plain). Ultimately,

painters and ecologists must decide what is foreground and what is background. Op-art painters and Salvador Dali played with the figure/ground dilemma in order to trick the human eye. Landscape ecologists more often trick their own minds. They watch a hedgerow when they should be watching the surrounding field or their eyes are on the field when the action is within the hedgerow. In what season is which the foreground?

But the lessons run deeper. Recent critics have a tendency to dismiss harmony, to reduce it to an arbitrary cultural prejudice. Redwood groves, fields of sunflowers, or a mirrored lake—all this is beautiful, but only in the eye of each beholder. The melding of art and landscape languages has within it the seeds of a new sensibility of harmony. Having deconstructed the purely human view of harmonious landscape, humans now have the joy of turning to landscape from richly different points of view: the beaver’s (page 30), the moose’s (page 10), the sapsucker’s (page 24), et al. This biocentric sense of landscape harmony owes gratitude, in part, to the modern and conceptualist painters. Tired of pastoral scenes of the cow, the beech tree, and the setting sun, they offer us delight in connectivity, in the composition of elements in space and their configurations, and intuitive senses of color and touch. ⊕



(continued  
from page 5)

goods and services for human benefit. and, in most cases, the harmful consequences of infrastructures have been unintentional. The Columbia River Basin dams built during the Depression are typical. The dams were not meant to send salmon runs to extinction, but their location and design have brought the salmon industry to the brink of ruin.



Too often, pride (personal and national) overwhelms an understanding of long-term consequences. This is known as the

Edifice Complex. The Tower of Babel tells the tale well. The Yangtze River Basin dams in China and the dream of five nuclear power plants in the state of Washington both sing the song of infrastructure hubris. The clash of ecostructure and infrastructure will continue. Megaprojects brew away in the pots of developers and engineers (page 47).

Today, infrastructure and ecostructure entangle on all scales, from the cellular to the axial rotation of the Earth. DNA splicing, for instance, occurs within a cellular landscape. It has ramifications for the agricultural infrastructure worldwide. On the other end of the spectrum, humans have modified the Earth's shell-like troposphere with

greenhouse gases, poked holes in the ozonosphere, and unbalanced the Earth on its axis enough to cause a detectable change in the length of our day (page 12). No scale of landscape remains immune from an alteration in composition or configuration from human infrastructures. As microchips hybridize with neural cells, some historians predict that the next generation will become comfortable with an artificial life on an artificial planet.

## Governors

Our use of the word "governor" is a bit special. Governors are devices that keep ships on course. They provide automatic control of the speed or power of the moving ship. We use it to mean: a structure exercising a determining influence on the volume or timing of a flow. Frontal patterns govern storms—their intensity, duration, and recurrence. A forest's architecture can govern intensity, duration, and recurrence of fire. Termites can govern how often you need to rebuild your home. Governors have to do with governance, not necessarily government.

The trail and the flyway are elements in the ecostructure of animal movement. The road and railway are elements of infrastructure.

Since early irrigation, civil engineers have tried to simplify and reconfigure flow patterns with a minimal number of parts and links. The design idea was to lower operations and maintenance costs, streamline the flows, and make safety simpler. In the process, civil engineering isolated infrastructure from ecostructure—the aqueduct from the river channel; the justice system from the labor component of business production; solar energy from fossil fuel energy.

But a shift has begun, especially in what constitutes a well-designed and appropriate "governor" (see box) within

the configuration of the infrastructure. Is it best to let the flood plains or a cement channel deal with floods? When can multi-purpose wetlands do the job of water purification (pages 38 and 56)? Should beavers—those toothful builders and wanderers with an obsession for the sound of running water—be governors of watershed ecology (page 30)? Or should human-built dams? How much should the sapsuckers, as heavy-beaked, enthusiastic well-drillers and cavity-makers, govern the forest (page 24)? How much should the woodcutter? When I worked in Senegal, a beautiful small game park in the prefecture of Cassamance



dried up after a decade of drought. The hippos began to head south for more water. They had to cross angered farmers' fields, roads with armed hunters, even towns. How can the highways and developed lands of humans also supply greenways and blueways for plants and animals to move in the face of climate change?

The answer, in part, comes from the observation of landscapes. Ecostructures and infrastructures have different safety features. For instance, an insurance company might prefer to write a policy for a home outside the 100-year flood plain, and trust the ecostructure, rather than write a policy for a home adjacent to a concrete flood channel and trust the engineers' safety predictions.

Ecostructures do not simplify, but rather baroquely connect and compose. A meandering river serves better than a straight-shot pipe. Ecostructures specialize in redundancies and repetitions. They tend to govern balances between myriad species, adjusting diverse population growths, and minimizing extinction rates. They have no known goal or will. They are not single-minded.

The most popular infrastructure activist is probably Peter, the Dutch boy, who stuffed his finger in a leaking dike and saved the Netherlands. Karen Silkwood, a more controversial heroine, blew the whistle on radioactive exposure of workers. Both of them shared a crucial insight: before anything else, pay attention to the infrastructure! For citizen

activists, their insights have become even more pressing, pragmatic, and radical. First consider the infrastructure's own internal governors—then think about government. This strategy is helpful because though people think they are managing a system, many times it is the hardware that is managing the people. In water supply, for instance, the size





## What Ecostructure and Infrastructure Have in Common

- ✦ They are both embedded in landscapes, deeply and intimately. Anything that changes their links or their configuration has rippling consequences, many times unperceived and unpredictable by human intelligence.
- ✦ The space of infra- and ecostructures is defined by geography. Infra- and ecostructure have more intense ramifications within the boundary created by their configurations. The frame could be from Alaska to Chile for a tern or from Europe to Siberia for a telecommunications company. But landscapes, seascapes, and skyscapes contain the pattern.

and configuration of pipes dictate the density and extent of suburban sprawl more often than the local zoning board. Planning departments and local governments fall victim to whimsical politics and pay-offs. The pipe size is more resistant to change and runs the logic of development. Similarly, in waste management, it may be best to focus on the incinerators, not air emission standards. When hospitals started using large numbers of plastic gloves, they

dumped them into their special incinerators and now hospitals release more carcinogenic PVCs than any other business. But the standards didn't even bother to mention PVCs. So, a new approach requires a new kind of homework. Citizens will find it useful to ask: What's the infrastructure involved?

What kind of governors does it have? What routing? What links to other governors? What capacity for each link? Considering infrastructure first can make the difference that is the difference.

Rethinking ecostructure and infrastructure had many pioneers, starting with Thoreau and Aldo Leopold (page 45). Groups like the Wildlands Project (page 16) and the Institute for Bird Populations (page 19) have combined citizen



science with descriptions of needs of wildlife. They attempt to paint a clear picture of ecostructure, then custom design land use and development that best fit

the landscape. Some cities and government agencies now conclude that decommissioning and deconstructing select parts of their infrastructure—highways, dams, nuclear power plants, levees, cemented channels—may benefit the economy and welfare of humans far more than keeping old infrastructures intact (page 48).

Some educators, NGOs, and consultants have undertaken a mission to convert industrial business enterprises to human and Earth-aware infrastructures (page 61). Difficult problems remain because markets do not favor gentle, integrated infrastruc-

- ✦ They are both composed of a collection of "governors" laced into a specific configuration. Each governor can slow or accelerate, change the scheduling, transform, re-route, or buffer a flow. Watersheds gather flows of water and solar energy; airplane terminals and railroad stations gather and disperse flows of people. Power plants transform fuels into electrons; plant leaves transform sunlight into sugars. Flood plains buffer floods; reservoirs buffer water supplies.
- ✦ Each part provides indispensable support to the function of the whole infrastructure or ecostructure. If one link deteriorates, the connectivity breaks and the whole geographic community suffers.

tures. They favor the promoter who gets there first (page 53). They favor selling a product, not solving a problem. Many times, they favor cutting the costs of safety and environmental protection infrastructure. A poor infrastructure locked in early can ruin the best plans and ideals of mice and men. Chernobyl, the oil fields of the Ogoni in Nigeria, and the recent toxic sludge spill in Spain demand a stronger discipline within the market. The salty soils of the fertile Crescent and the Anasazi ruins send Ozymandius reminders from the past.



The dream is clear. The old stories harbor prayers for the plentiful return of journeying creatures of sea and sky, and good omens for all. In this, the new stories are just like the old. Now the mysterious lands have been more closely

mapped and tied to our own destiny. We have begun to learn what happens to salmon and turtles on the high seas, and where the swallows winter. The dream is ancient human wisdom: know and respect the ecostructure of our labors; plan, design, and labor for all species, not just our own; and for our children's children, not just ourselves.

Because humans have been so successful in re-engineering the ecostructures of the biosphere, the new dialog must include both the architects of infrastructure and the keepers of the land. The mutual goal is an infrastructure that will manage, but not exploit, the flow of those goods and services provided by the planet, and an infrastructure that meshes gently within the landscape. We hope this issue of *Whole Earth* can be a small educational vehicle in this endeavor. If it can, it may also alleviate some suffering, elevate the cheer and good spirits of the landscape's community. We tried this once before, in 1976, with a special issue on watersheds. It took about twenty years for the Environmental Protection Agency to consolidate its watershed program. Maybe this issue can speed things along. ✦



Infrastructure and ecostructure govern flows. Here are structures with different capacities to govern water flows.





**E**costructure returns a richness and vividness to our conversations about the planet. (“Environment” has been almost depleted of meaning by politicians and policy wonkers.) Ecostructure is the collection of the more inflexible, rigid parts of the biosphere that guide and alter the speed of events. Like walls and hallways, the furniture, and appliances in a building, ecostructure governs the drama and pace of living in the Earth’s household.

This section broadly sweeps through examples of ecostructures of the biosphere. The axis of the Earth and its orientation toward the sun is the overwhelming structure of the biosphere, influencing day length and seasons and weather. Bob Scarborough describes our planet as an ice skater, and shows how humans appear to have shifted her axis and speed of spin. The next essays descend in scale to the globalists—the migrating birds, grizzlies, bats, sea turtles, butterflies—whose ecostructure connects the ecoregions of the planet (pages 16-23). Then, Paul Ehrlich and Gretchen Daily give a more intimate picture of how a single bird can multiply the connectivity of a watershed by altering its ecostructure (page 24). Even rafts of plants act as governors. Water hyacinth rafts, for instance, help purify waterflows (page 38). The section ends with Wes Jackson dropping down into the most intricate ecostructure known, the cell. He questions the wisdom of tinkering with one part (the DNA) without expecting the other parts to reconfigure the cell itself (page 39).

It is awkward to invent a word. Try, however, to think of any part of the whole—its edges, resistance to change, resilience in the face of change, lifespan, place in a landscape of any size—and the comedy of permanence and joys of governed flows may just bring an affectionate appreciation to the tapestries of “ecostructure.”

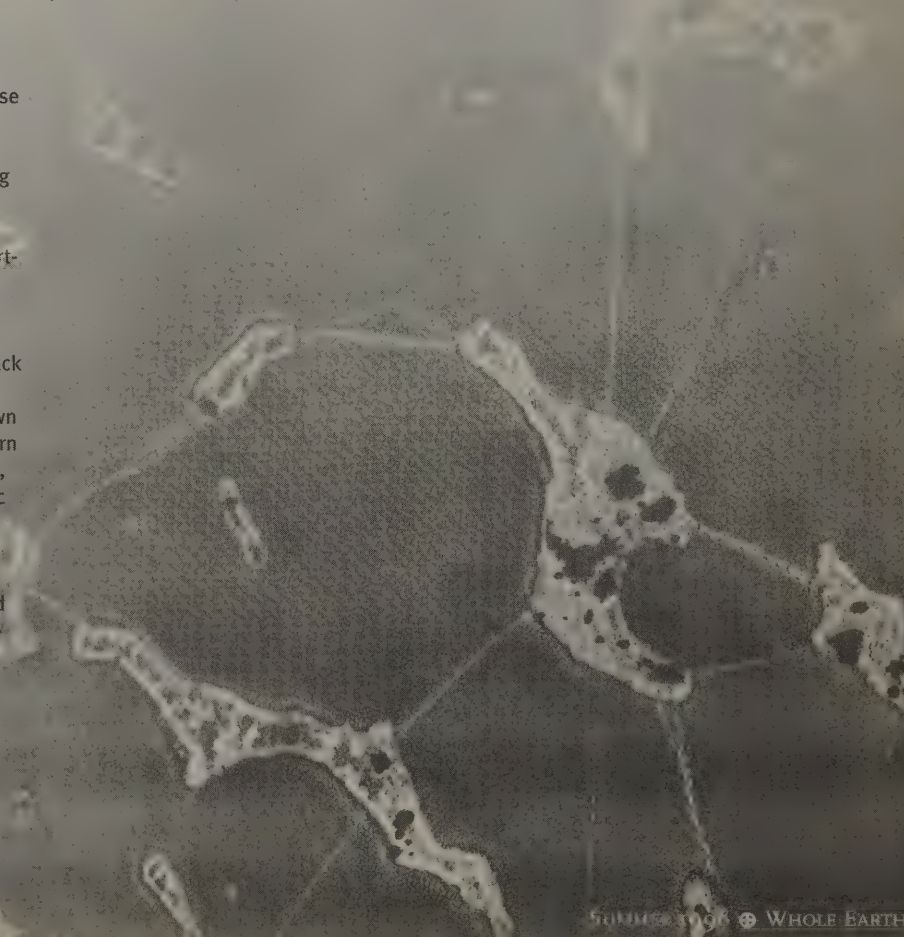
In the “Ecostructure of the Moose” (opposite) we roam through a small part of the moose-works on Isle Royale, Lake Superior, and point out each part that governs the abundance of this gawky, huge, palmate-antlered, hoofed deer. One prime ecostructure is the weather. Rarely thought of as having structure, winter frontals are bounded cold air masses that form an edge with warm air from the south. The contrasts between the two air masses, their patchiness, and their configuration, govern the amount, density, and extent of snow. The snow, in turn, can bury the vegetation the moose browses upon. Too deep, the moose starves. In addition, the snow’s hardness can turn the tide in the chase between light-footed wolves and heavy-footed moose. Too deep and too soft snow and the moose sinks into the drift. The storm and the snow are major parts of the moose-works and mutually govern moose winter

starvation and vulnerability to wolf predation.

The structure of the moose population can shape the landscape mosaic of Isle Royale. Many adults, moving along moose trails, browse down the adjacent patches of edible plant life. The shortened shrubbery becomes more likely to be buried in snow. The moose has sent itself into a negative feedback loop by “over” browsing. It has, in part, designed its own destiny. The browsing pattern also changes the risk of fire, its intensity, and geographic spread. Moose browsing helps design fire control or fire buildup. The moose shapes its ecostructure, and partly determines the abundance of moose food in its outdoor cupboards.

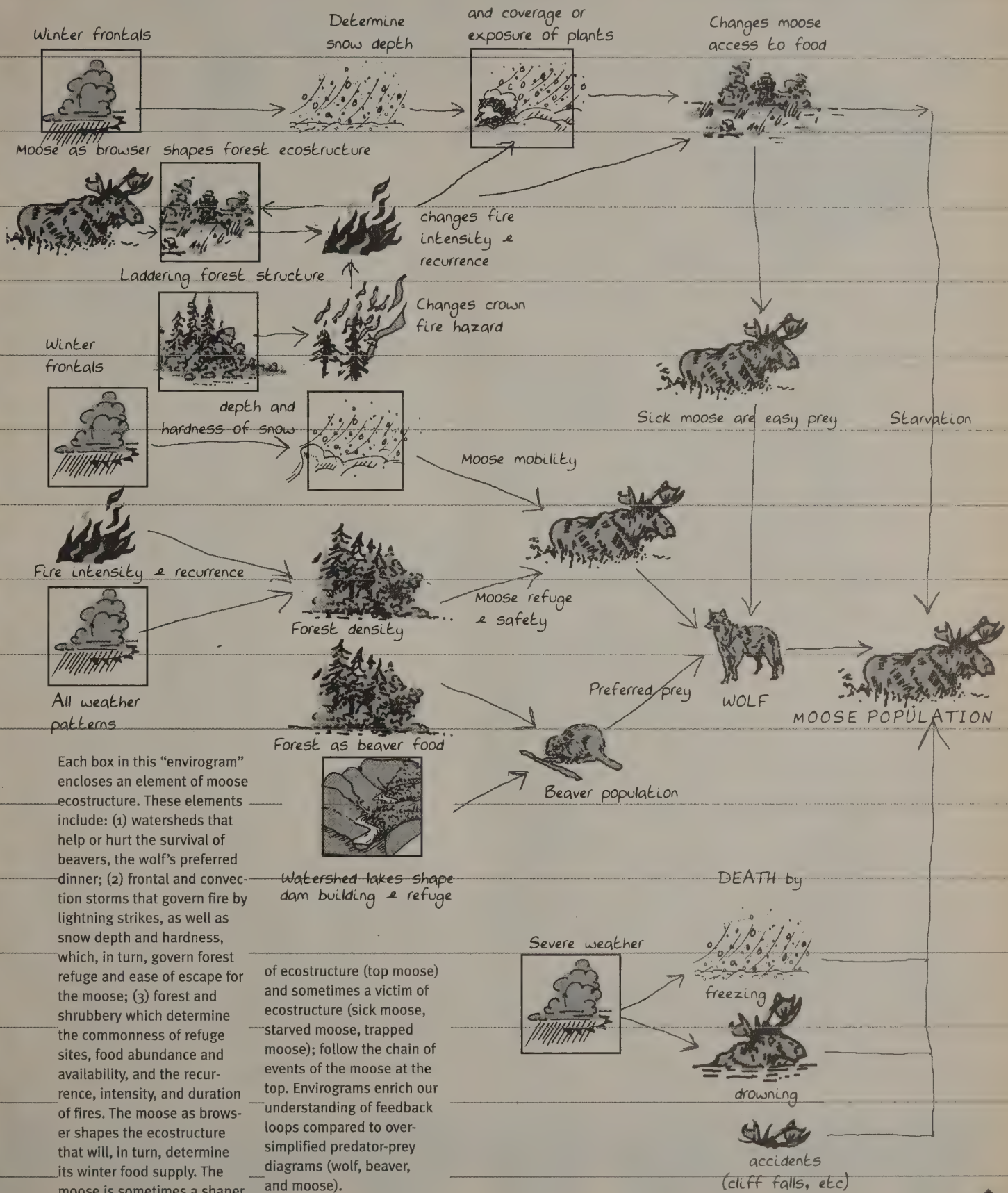
Right: Animal trails connecting an array of differently sized waterholes, Dry Lake, CA.  
—PHOTO BY W.A. GARNETT.

# ECO STRUCTURE





# Ecostructure of the Moose



Each box in this "envirogram" encloses an element of moose ecostructure. These elements include: (1) watersheds that help or hurt the survival of beavers, the wolf's preferred dinner; (2) frontal and convection storms that govern fire by lightning strikes, as well as snow depth and hardness, which, in turn, govern forest refuge and ease of escape for the moose; (3) forest and shrubbery which determine the commonness of refuge sites, food abundance and availability, and the recurrence, intensity, and duration of fires. The moose as browser shapes the ecostructure that will, in turn, determine its winter food supply. The moose is sometimes a shaper

of ecostructure (top moose) and sometimes a victim of ecostructure (sick moose, starved moose, trapped moose); follow the chain of events of the moose at the top. Envirograms enrich our understanding of feedback loops compared to oversimplified predator-prey diagrams (wolf, beaver, and moose).







# WHEN RIVERS DON'T RUN TO THE SEA

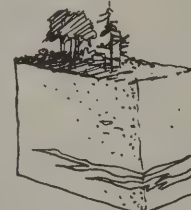
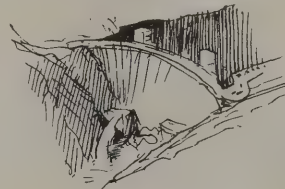
...the Earth  
spins faster and  
days shorten

**T**he Earth is a liquid planet. It's easy to say: the Earth is a liquid planet. It's hard to keep as an everyday thought. We want to consider it solid, but the Earth's equator bulges twenty-seven miles in diameter due to our planet's quick spinning, just the amount expected if the Earth consists of viscous fluids, not solids. The best model for the Earth's physicalness is the lowly chicken egg with gooey yolk and a super-thin, brittle shell. Really, two kinds of shell—one thin, one thick—floating side by side in irregular patches, loosely glued together, corresponding to oceanic and continental crust. Our Earth, with its spreadable middle, is closely analogous to the figure skater who effectively controls her speed of spin with her lightweight arms by tightening them to her chest or raising or lowering them above her waist. Humans, by changing the distribution of water's mass on the planet, appear to be changing the Earth's speed of rotation. And any action on our planet which moves mass away from or toward the Earth's axis of rotation produces this secondary impact: changing the spin speed, which we call the length of a day.

Atomic clocks, used since 1955, allow the study of day-length changes with amazing detail, down to less than a nanosecond (a billionth of a second). The radio signal broadcast from radio station WWV, Ft. Collins, Colorado, the nation's most boring but uniform station, is fine-coupled to a zenith telescope at the US Naval Observatory in Washington, DC. Together, they measure day length by successive passages of certain stars past the telescope's cross-hairs.

With atomic clocks, the tiniest day-length perturbations become apparent. As the moon and Earth separate by about three centimeters per year, the Earth slows slightly and a very gradual lengthening of the day (0.0022 seconds/century) is inevitable. Earth historians think about this figure. It means a loss of twenty-two seconds each million years. A billion years ago a complete day was less than twenty hours. That's only one-quarter of the way back in Earth history and, proportionately, the shorter days sported more vigorous tides forced by a closer moon, stressing the shorelines and early life.

The atomic time measurements have helped refine how the annual atmospheric circulation cycle causes variations in day length by shifting the amount of water to and from land, air, and seas. Together with a mysterious 433-day-long Chandler wobble, the shifts in water mass in the water cycle account for about 0.3 seconds in the day-length passages. The ocean/air circulation is the most prominent, with masses of water amassing in one biospheric "structure" and draining another. Thus the re-rerouting of the jet stream between average



**ROBERT SCARBOROUGH**

WATER CYCLE SKETCHES BY MALCOLM WELLS

Natural disturbances in the spin of the Earth.

Lunar/Solar Gravitational Attraction

Sea-level Loading

Atmospheric Loading

Melting of Ice

Groundwater

Erosion/Sedimentation

Winds

Ocean Currents





winter and summer positions, seasonal monsoonal tracks, summertime high-pressure mushrooms over deserts, and El Niño surface currents are all biospheric “structures” transporting varying volumes and masses of air and water that push against undersea and terrestrial mountains and so affect the Earth’s rotation.

Even with these variations accounted for, there are still dozens more day-length perturbations through a typical year which produce total variations of about 0.6 seconds. The causes are numerous (see figure): ice melting, groundwater flux, erosion into the sea or undersea landslides, plate and mantle movements, etc. They all shift the weight distribution of the spinning planet.

Day-length shifts due to human influences are now under consideration. The most weighty candidate, according to Benjamin Chao of NASA-Goddard, is the impoundment of river waters in human-built reservoirs. Within the last forty years, Chao estimates that civilization has transferred ten trillion tons of water from the oceans to northern hemisphere reservoirs and, by doing so, decreased the Earth’s angular momentum, and shortened its day length by eight-millionths of a second. He figures that the reservoir effect is about one-hundredth the size of all other short-term impacts, but clearly measurable. Since the reservoirs are not distributed evenly about the northern hemisphere, the Earth has become a more wobbly top which has pushed the north geographic pole two feet toward western Canada. Chao takes into account the drying up of the Aral and Caspian Seas and the drawdown of the High Plains aquifer of the US Midwest, all of which have subtracted about a thousand cubic kilometers of water (a quadrillion tons;  $10^{15}$ ) from this northern reservoir effect.

Another human influence on day length may appear by close monitoring of sea level changes which alter the equatorial bulge and significantly change the Earth’s angular momentum. (To exaggerate grossly, picture a figure skater with a beer belly.) The largest sea level change occurred ten to twenty thousand years ago as the last Ice Age glaciers melted and added a whopping 400 feet to sea level. For the past several decades sea level has risen by 1.6 to 2 millimeters per year (about 0.7 inches per

decade) for unexplained reasons. As the biosphere heats up under the greenhouse effect, sea levels rise because water expands when warmer, and glaciers continue to melt. Glacial ice that has melted in the twentieth century should have raised sea levels by an estimated 4.4 centimeters (1.75 inches) but this impact has been largely offset by filling of the 10,000 human-built reservoirs, which store about 10,000 cubic

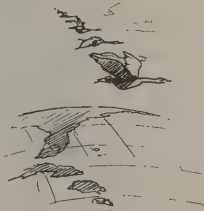
kilometers of water. Thus, both the greenhouse effect and the reservoirs nearly cancel, masswise, though the change of location of this weight still impacts day length.

The net rise in sea level remains unexplained for now. Chao notes that his calculations did not include the saturation of water in the rocks and soils around the dam site. If this volume and weight is significant, and Chao believes it is, then the current rise of sea level is even more mysterious, a foretelling of some deep internal planetary change.

The fluidity of the planet serves as a sounding board, vibrating from various prehistoric Earth wobbles, jolts, and shifts in the alignment of the planet’s axis, corresponding with stories found in the apocalyptic Hopi creation myths about the pole star as well as serious twentieth century scientific hypotheses. Water has been transferred from the seas to northern reservoirs; the Earth spins faster to conserve angular momentum; the days shorten from the faster spin; and the whole system’s kinetic energy (energy of motion) increases. The skirt of the whirling skater flaps differently with unknown impacts on our lives.

Sometimes we lose sight of the orbital and solar system structure which contains these changes. Chao estimates that the speedier spin of the Earth from all the reservoirs requires 30 gigawatts of energy, the equivalent of about three percent of all human power production. This energy is all solar energy—evaporating sea water, driving the climate, and filling the reservoirs—it traces directly back to our tiny fraction of a star’s light. ⊕

Bob Scarborough meets my test for a great geologist—his name appears on map after map from his walking and looking at the Earth. When we worked together, he discovered the southernmost glacial features in the US on Mt. Graham and dozens of hillslope slides in Malibu; constructed the soil profiles of Biosphere2, and taught on many of our maniacal naturalist tours. He’s now part-time hydrogeologist at the Arizona-Sonora Desert Museum and writing/illustrating a book on the West’s geological history. —PW



*All rivers run to the sea, but the sea is not full; unto the place whence the river comes, thither they return again.*  
—Ecclesiastes 1:7

Mantle Convection

Plate Tectonics

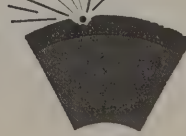
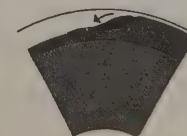
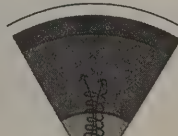
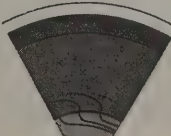
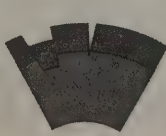
Earthquakes

Viscous Torques

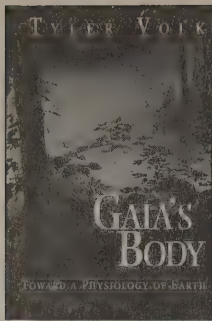
Electromagnetic Coupling

Underwater Landslide

Meteor Strike







## Gaia's Body Towards a Physiology of Earth

Tyler Volk. 1998, 269 pp. \$27. Copernicus, an imprint of Springer-Verlag.

This is a book about geophysiology by a scientist who for many years has been working on ecological life-support systems for NASA. He takes James Lovelock's brilliant work on the Gaia theory as a starting

point, and continues the task of opening up endless intricate filigreed details of Gaia's physiology and metabolism. No doubt we will see more writing of this kind in the future, which is just as well. We desperately need to learn more respect for, and more about, the planet of which we are quite literally a working part: "the key processes of Gaia are best seen by looking right through the borders of organisms."

There are still many unanswered questions, and the mystery seems to deepen the more understanding we gain. The author dodges the mystical implications of the Gaia concept but, nevertheless, Volk does a good job of creating a sense of wonder to act as a counterpoint to the engineering side of industrial ecology. —Hardin Tibbs

Leaf and human. The relative areas of the circles show the abundances of elements in both plants and humans.



tions. Gaia is singular; it did not evolve by births and deaths in the Darwinian way. But as we have seen, many of the functions that organisms had to invent for themselves Gaia has obtained for free. To the thermally driven swirling of the atmosphere and ocean we should add the gravity-induced flows of rivers as one of these gifts.

At a landscape scale, rivers serve the ocean. The mouths of rivers are portals to the bodies of oceans. At these broad mouths the land's losses become the sea's gains. Were it not for rivers and the ions they carry, the oceans would support very little life.

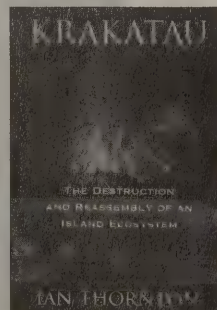
"Fantastic voyage" is an apt metaphor for the scientific quest to understand Gaia. To repair damage caused by humans, the crew travels through the passageways of a body made by nature. Isn't that our current situation? We inhabit a global metabolism with a four-billion-year pedigree. In just the past few decades, we have awakened to an awareness of damage we ourselves are inflicting on this metabolism with our blind urges to procreate and appropriate. Perhaps in the fantasies of many, the "taxi outta here" would be a time machine. Just tell the time taxi to stop at nature a thousand or more years ago. But because most of us would want to keep the postal service, the Internet, MRI scans, and an abundance of items in stock at a local supermarket, we must proceed with the world as it is, and that requires knowing how the foundational processes of nature work. I am convinced that such knowledge, if widely held, will contribute to shaping the future of Gaia—a future in which we, as a new biochemical guild, will necessarily be integrated into the global metabolism, for better or for worse. We can make it for the better by promoting an informed reverence for Gaia's body.

The blood system evolved as a functional part of animal bodies in popula-

## Krakatau The Destruction and Reassembly of an Island Ecosystem

Ian Thornton. 1996. 346 pp. \$18.95. Harvard University Press.

The landform structures blew apart. Molten lava and ash assured death to all plants and animals, including 36,000 humans. Then, over a century, the community reassembled itself and unexpected connectivities appeared. This book tells how. Information-rich, staidly but clearly written, it's the only book I've read that deals with the problems I encountered when attempting to start up and weave a food-web with the "island" of Biosphere2. Hands-on biodiversity; thoughtfulness testing the generalizations. —PW



A male crocodile was shot near Sertung's brackish lagoon in 1924...and Mrs. R.W. van Bemmelen is reported to have been "surrounded by snapping alligators" on Panjang, while her geologist husband was away from camp on Rakata, presumably in the 1950s....This the largest of all crocodiles has been frequently reported in the open sea by Malay fishermen....Wood-Jones(1909) reported that two specimens had reached Cocos-

Keeling Atoll from the nearest possible source 600 miles distant.

The raptors' roosting areas were high on the inner cone, which has now been subsumed by a new, higher one. If avian raptors have indeed been banished, and if appropriate plant species have survived, a period of unhampered colonization by pigeons may follow. Immigration rates of bird-dispersed shrubs and trees may be restored for a time, until raptors recolonize. The differential effects of volcanic activity may thus be complex.

The "super-tramp" colored kingfisher, an early and successful colonizer.

Very soon after the 1883 eruption, from a large floating tree trunk in the straits, a macaque monkey was picked up, fur-charred and miserable but alive and otherwise in good shape. Monkeys have not yet colonized the Krakataus, but given time and a reliable food supply, they probably will.

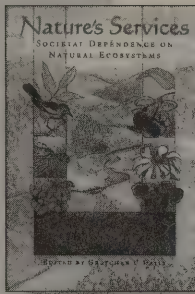




## Nature's Services Societal Dependence on Natural Ecosystems

Gretchen C. Daily, editor. 1997; 392 pp.  
\$24.95. Island Press.

Should we try to compute the financial value of the water cycle? What about the wind pollination of vegetables? Or the sequestration of carbon by the ocean? Even the posing of such questions seems at first suspect and even abhorrent, as if the obviously sacred were being violated by reduction to cold cash. But the experts in this book show otherwise. Their steady-paced, scholarly presentations—especially when taken as a whole—open a new window of understanding upon the organs of Gaia. Key is the systems approach inherent in the calculation of total social losses when natural assets are destroyed (or of total costs for technological replacements), the approach rallies us to build the best possible trellises from current sticks of knowledge. It also brings to the fore our most pressing points of ignorance about nature's complex chemical, genetic, ecological, and climatic workings. —Tyler Volk



“This value formation through public discussion...is essential to integrate the three goals of sustainability, fairness, and efficiency and can be seen, in fact, as the essence of democracy. As

Buchanan put it: “The definition of democracy as ‘government by discussion’ implies that individual values can and do change in the process of decision-making.” Limiting our valuations and social decision making to the goal of economic efficiency based on fixed preferences prevents the needed democratic discussion of values and options and leaves us with only the “illusion of choice.”

What are the implications of all this for the valuation of ecosystem services?

—ROBERT COSTANZA AND CARL FOLKE

“A summary review of ecosystem services in several dozen tropical forests indicates that the hypothetical overall value of sustainable use of one hectare of forest is about \$220 per year, made up of: minor forest products \$69, recreation \$12, watershed functions \$10, hunting and fishing \$5, option and existence values \$16, and timber \$110 (49 percent).

—NORMAN MEYERS

## Global Change A Review of Climate Change and Ozone Depletion

Irving Mintzer, Executive Editor. Hard-copy version: free from the Pacific Institute, 654 13th Street, Preservation Park, Oakland, CA 94612; 510/251-1600, fax 510/251-2203, circulation@globalchange.org, www.pacinst.org/pacinst. Electronic edition: www.globalchange.org.

This is the best and most readable quarterly on the subject, with the latest news and books. All the articles appear first in the electronic edition, plus additional material and lots of links. Need to know the cost trade-offs to “developing” vs. industrialized nations? What is the news from the latest monitoring of solar radiation, animal indicators, or higher UV-B? It includes the kinds of impacts in which ozone or climate change play a role, such as New Guinea's food shortages. Will Clinton/Gore, efficiency, or alternative energy live up to their rhetoric? The turbulent currents of public policy and private investment eddy out here. —PW



“Solar output has increased slightly over the past decade. ...If the trend continues, this process could warm the Earth 0.48°C (0.72°F), over the next century, in addition to the predicted 1.0-3.5°C (1.8-6.3°F) warming anticipated from greenhouse gases.

## The Forging Air Understanding Environmental Change

Richard C.J. Somerville. 1998; 195 pp. \$13.95. University of California Press.

Richard Somerville, a professor of meteorology at the Scripps Institution of Oceanography, understands the weather and the way our atmosphere works. He recently updated his 1996 classic in order to expose the general public to the workings of the global weather machine. This clear and eloquent guidebook illuminates the ways in which human activities are changing the composition and behavior of the atmosphere.

Somerville is a scientist with a strong link to the far older legacy of oral tradition. He is first of all a good story teller. He explains complex atmospheric phenomena by telling the tales of real-life scientific discovery. He links these discoveries to the political processes leading to recent international agreement that protects the global environment. In this way, he opens the processes of scientific discovery and international negotiation to inspection by the concerned non-specialist, someone with an interest more in the implications of environmental change than in the equations of atmospheric physics.

**The Forging Air** is a new and important addition to the public debate on global atmospheric change. For those who want to understand how everyday activity is changing the atmosphere and to think systematically about managing the resulting risks, Richard Somerville sheds a sharp, clear light on a complex web of interacting phenomena. —Irving Mintzer

“I confess there's something fascinating about climate modeling. It's computer simulation of a high order. You can turn a knob and make the Earth spin faster or spin backwards, you can turn the Sun off, you can make the seasons disappear, or you can change the atmospheric carbon dioxide. Of course, you're doing all this with a make-believe Earth, not the real one. Some people, unfortunately, tend to believe literally everything that emerges from the model. Many things from the real climate system aren't included in climate models. Planet modeling by computer simulation is an exciting area of research that's fun to learn about. But the results are broad-brush overviews of the climate problem, not precise depictions.





# WILDLANDS

## THE GRIZZLY'S CREED

### Think long, act now

- \* Envision the next century or two—weather's ups and downs, wildcard storms, acid rain, unknown tree diseases. Nurture a future of many connected landscapes. This will be the sustainable community and the joy of future citizens.
- \* Chart long-distance routes—greenways, blueways, skyways, floral ways—for animals and plants to move and migrate.
- \* Start re-introductions now. They may take decades to settle in, with many failures before success.
- \* Design eternal stewardship today, never as an afterthought.

### Think short, act now

- \* Configure the trails, corridors, stop-over points, core areas, and buffer zones for today's residents, visitors, and migrants. Consider their daily life and seasonal moves.
- \* Compose the landscape. Minimize stark, hard-edge transitions. Favor multiple, wide pathways.
- \* Manage narrow corridors and small fragments intensely. Big acreage can take more care of itself. Enrich the small and narrow by introducing complexity.
- \* Weave a fine lacework of life support and diversity. Think links and gaps, independence and interdependence—at the same time. Between "islands of favored land," minimize gaps.
- \* For unique populations that have been evolving in Bohemian ways, maintain the gap. Quarantine patches of degraded and disturbed landscape until they can be safely linked.

### Compose your Eden, then persevere

- \* Cardinal rule: Each landscape is unique with its unique diversity.
- \* Give special attention to those most at risk. Rescue rare and small populations from extinction.
- \* Design for native species and the ecostructures that offer them life. Include top predators, co-evolved pollinators, and the creepy crawlies that recycle life. Don't forget the soils and stability of watersheds.
- \* Maximize the landscape that is most supportive. More acres are more safe. Build barriers to the dispersal and population expansion of introduced species.

### Use what's here

- \* Take account, become intimate with what is actually here.
- \* Start composing with nature's long-evolved landscapes—before reconstructing a landscape from an image in your mind.
- \* More humanized landscapes are not hopeless. They do mean more intense management, more precise design, more discipline to limit human influences, and more constant and rigorous stewardship. There's less play in the system.

### Give evolution a chance

- \* Configure and connect a rich mosaic of landscapes. Design an elaborate geometry of routes that nurtures gene flow between populations.

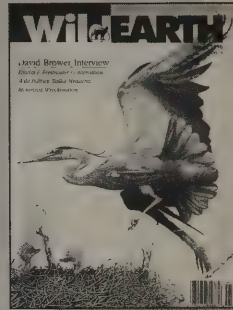


### The Wildlands Project

\$100+ donors receive **Wild Earth** free. 1955 West Grant Road, Suite 148A, Tucson, AZ 857445, 520/884-0875, wildland@earthlink.org, www.wild-lands.org.

### Wild Earth

Dave Foreman, publisher. \$25/yr (4 issues). PO Box 455, Richmond, VT 05477, 802/434-4077, fax 802/434-5980.



**Wildlands** and its prime voice **Wild Earth** are the most effective American lever, moving almost inert states and nations to consider the landscape needs of large mammals and migrating birds, bats, and butterflies. A tiny organization with a breath-taking vision, their ideas and energy have—like the slap of a Zen master's stick—awakened even the smartest ecologists, quite a few ranchers, and myriad dozing bio-bureaucrats. Large mammals need large landscapes and, in an ever-changing world dominated by human fiddling, **Wildlands** helps locate, design, configure, connect, and protect the Big Outdoors that big critters require.

**Wildlands** maps relatively protected areas that appear like odd-shaped globs of paint in modern art; they find local grass-roots activists to dream up new landscape connections and configurations that spread over hundreds of miles and blithely cross international boundaries. They define the barriers (including private ownership) to bridging the gaps, and push the federal agencies to try to duplicate their efforts. They're adaptive and inclusive, kind of the Forefathers and Foremothers of what future Americans will come to cherish most: time out from urban mind, spotting a caribou herd or a trumpeter swan, the rumor of a jaguar, the song of wolves. These quintessential "ecostructuralists," working on large landscape scales, have clear minds, good humor, and eminently practical advice on the four C's (connectivity between fragments, composition of communities, and sustainably configured landscapes). Amen. —PW

Summarized and composed by Whole Earth, with thanks to the work of M.E. Soulé, Reed F. Noss, and the Wildlands Project.



## Multinational Greenways

### Yukon Wildlands Project

Juri Peepre, 30 Dawson Road, Whitehorse, YUK Y1A 5T6, Canada, phone/fax 867/668-6321, [peepre@yknnet.yk.ca](mailto:peepre@yknnet.yk.ca).

YWP works largely to protect areas that have not yet been fragmented. They research regions and animal movement patterns that are not yet well understood, in cooperation with First Nations people, to take advantage of local knowledge. They work through federal, territorial, and First Nations governments to protect areas before mining, logging, and development interests move into them. Transnational animals in the region include grizzlies, birds that funnel into the Yukon on their way up the Rocky Mountain trench, and porcupine caribou traveling between the Yukon and the north coast of Alaska.

### Yellowstone to Yukon (Y2Y)

Bart Robinson, 710-9th Street, Studio B, Canmore, AB T1W 2V7, Canada, 403/609-2666, fax 403/609-2667, [y2y@banff.net](mailto:y2y@banff.net), [www.rockies.ca/y2y](http://www.rockies.ca/y2y).

Y2Y is a coalition of more than 100 groups collaborating to tie the core natural reserves—Grand Teton, Yellowstone, Glacier-Waterton Lakes, Banff, and Jasper National Parks—into a chain of reserves, buffers, transition zones, and corridors stretching up the Rockies from Wyoming to the MacKenzie River. Border-crossers: grizzlies, wolves, bald eagles, trumpeter and tundra swans, and salmon. Read *A Sense of Place: Issues Attitudes and Resources in the Yellowstone to Yukon* (see website).

### Greater Laurentian Wildlands Project

Robert Long, 4 Laurel Hill Drive, South Burlington, VT 05403, 802/864-4850, [glwildland@sprynet.com](mailto:glwildland@sprynet.com).

The "A2A" consortium—Algonquin Provincial Park in

Ontario to Adirondack Park in New York. **GLWP's** current priority is a draft design for Maine Wildlands Reserve Project. Focal species: lynx, cougars, pine martens, possibly wolves.

### RESTORE the North Woods

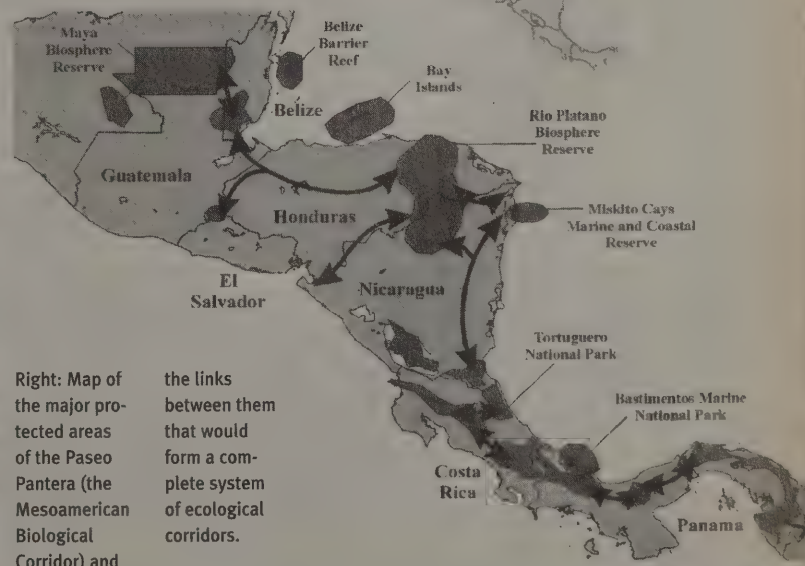
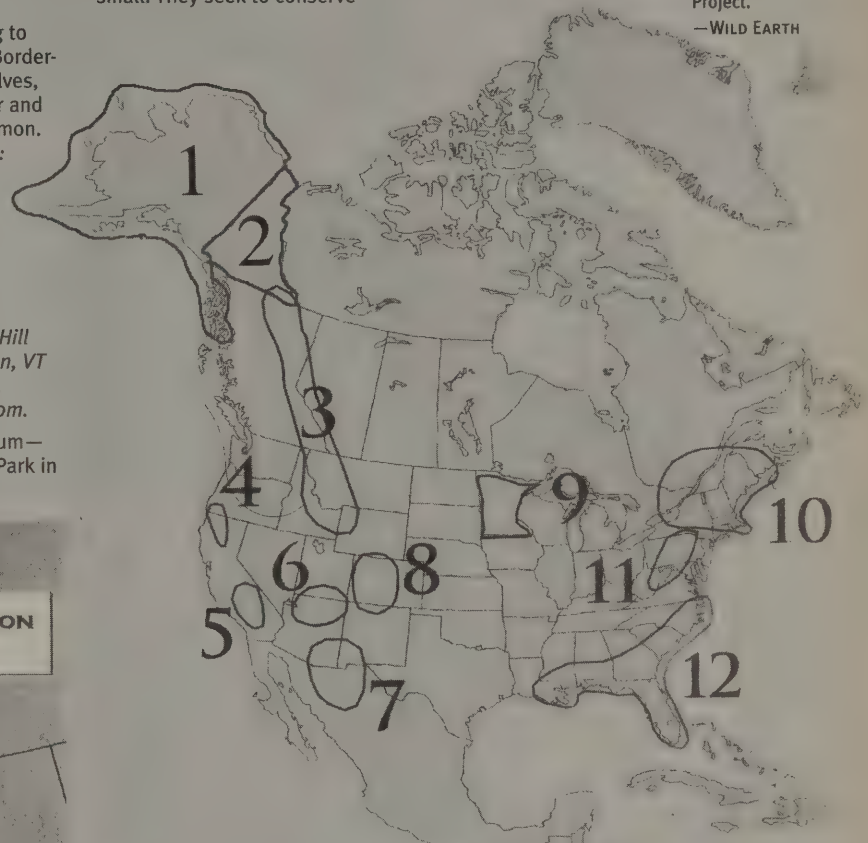
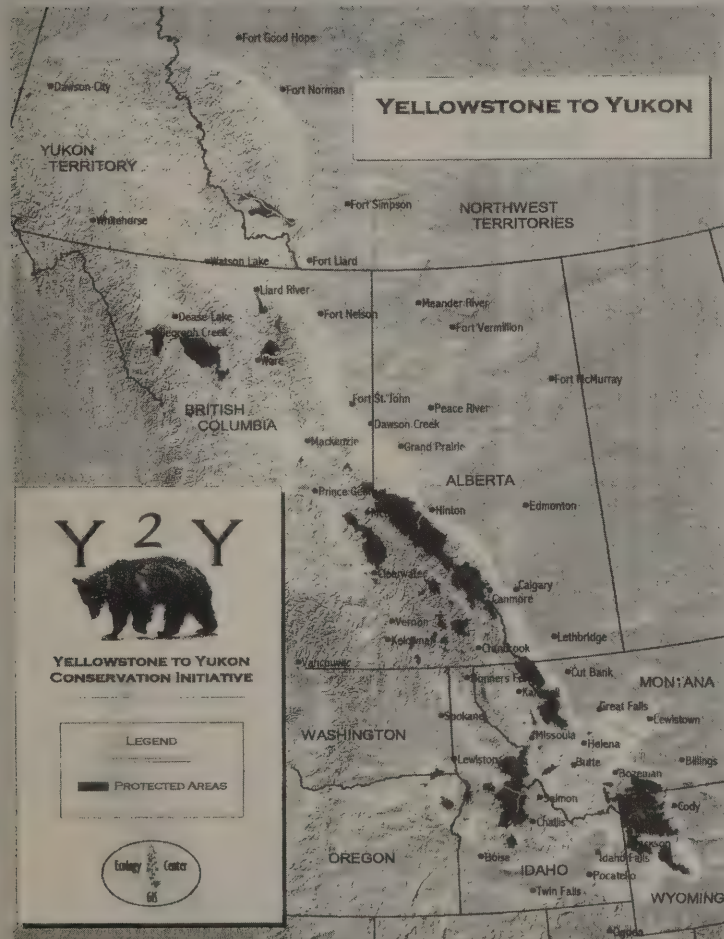
PO Box 1099, Concord, MA 01742, 508/287-0320, fax 508/287-5771, [restore@usa1.com](mailto:restore@usa1.com), [www.restore.org](http://www.restore.org).

No one is accusing **RESTORE** of thinking too small. They seek to conserve

the ecosystems of the North Woods, on both sides of the US-Canada border from Nova Scotia to Manitoba. Their more modest interim project is creation of a Maine Woods National Park and Preserve that would be larger than Yellowstone and Yosemite combined. Critters slipping across the border without passing through customs include Eastern timber wolves, Atlantic salmon, and harlequin ducks.

Below: Wildlands Project endeavors. International efforts include: (2) Yukon Wildlands Project; (3) Yellowstone to Yukon; (7) Sky Island/Greater Gila; (10) Greater Laurentian Wildlands Project.

—WILD EARTH



Right: Map of the major protected areas of the Paseo Pantera (the Mesoamerican Biological Corridor) and

the links between them that would form a complete system of ecological corridors.



# SKYWAYS, GREENWAYS

**B**irds have always been the point guides and inspiration of citizen science. Now, with multinational concerns, citizen scientists are the only possibility for decentralized, intense tracking of avian global changes. The **Institute for Bird Populations** is the hub of this birder infrastructure. Working with Audubon, the Department of Defense, and Cornell Laboratory, the **Institute** has pioneered in recruiting and training citizens and developed techniques to improve "non-professional" identification and reporting of information. Their Bander Outreach and Training Program educates citizens for their Monitoring Avian Productivity and Survivorship (MAPS) stations. They now track over 100 species at about 450 stations (including Guantanamo Bay Naval Station in Cuba), and print the best field guide for in-the-hand birding, a *MAPS Manual*, a safety manual, and a solid academic journal. (They do lots of other stuff too!)



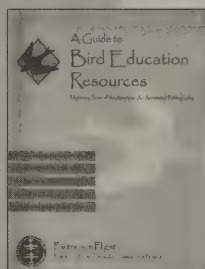
Where is the difficulty? At the breeding site, from toxics, loss of nesting sites, ecostructure modification, increased exposure to predators, and the parasitic cowbird? Habitat loss and seasonal food shortages? Weather system changes? Stop-over points in migration? The wintering grounds? By placing numbered bracelets on the legs of birds and re-capturing them in mist nets, citizens keep tabs on the ups and downs and supply bio-statisticians at IBP with enough info to figure it all out and focus conservation efforts.

The "twitchers" (birders) of Britain, of course, started all this with their Constant Effort Sites Scheme and its "constant effort" mist netting that requires local volunteers. Cornell Lab has great programs for citizen observer-reporters, such as checking bird boxes for breeding success (the Nest Box Network), checking who shows up and when at feeders (Project FeederWatch), and specific forays to identify forest birds and the endangered Cerulean warbler. Cornell gives citizens a new home for their observations at **BirdSource**, where real-time tracking of birds can be shared on the Internet. In the near future, the weather report may include radar reports on where the birds are now. **Partners In Flight** is the government/NGO connection. We may be witnessing the dawn song of scientific democracy at its best, thanks to our warm feelings for our fine feathered friends. ☺

## A Guide to Bird Education Resources

### Migratory Birds of the Americas: An Annotated Bibliography

Sarah B. Laughlin and Diane M. Pence, eds. 1997; 142 pp. \$9.95 (\$13.70 postpaid). American Birding Association, 720 West Monument Street, Colorado Springs, CO 80904, 719/578-9703, fax 719/578-1480, www.pif.nbs.gov/pif/birdbib.



The one-stop shopping catalog for access to bird migration and educational resources. Wonderfully laid out. Evaluation includes one-to-five swallows ratings.

These are very fair and accurate assessments, with sample pages. Books, games, videos, kits, interactive websites, field trips for both teachers and students. We have rarely seen such a well-done guide to anything. For migration programs see: *Birds Beyond Borders*, *One Bird-Two Habitats*, *The Songbird Blues*, *The Songbird Connection*, and *Teach About Geese* (all rate five swallows). —PW



### “ SAVE OUR MIGRATORY BIRDS

Author/Editor: Manomet Observatory for Conservation Sciences, Conservation International-Canada, Econciencia A.C.

in Mexico, and Fundacion Vida Silvestre Argentina.

...Provides global perspective on the birds which link the continents with their seasonal migrations. It is designed to link schools in the different countries through penpal programs and can be used with Shorebird Migration Game.

Type: Curriculum and partner project.

Language: English and Spanish versions.

Key Topics: migration, habitat, songbirds, shorebirds, environmental issues.

Target audience: Teachers of grades 6-8.

Disciplines: Science, Geography, Language Arts, Math.

Length of Unit: With the penpal project, activity spans an entire school year.

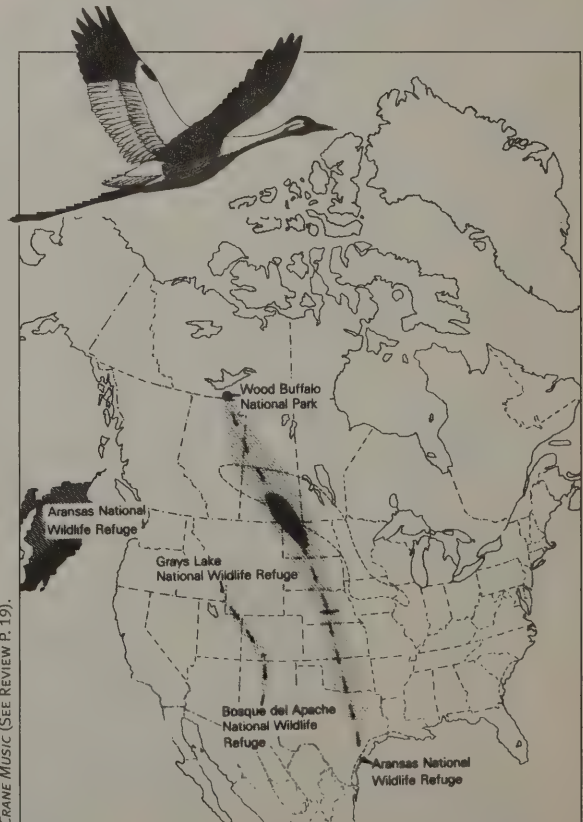
Instructional Environment:

Classroom, schoolyard, natural areas.

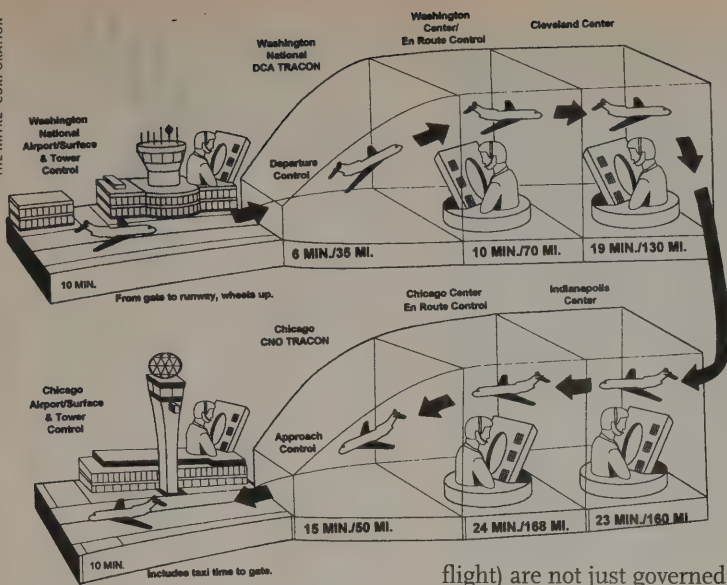
Format: Text is duplicated sheets to go in a binder; 114 pages.

Material Addresses: Investigative skills, concept awareness of the natural environment, evaluation skills, environmental action skills, ecological foundations.

Adaptability to other regions: Already good for English and Spanish speaking classes in all the Americas.



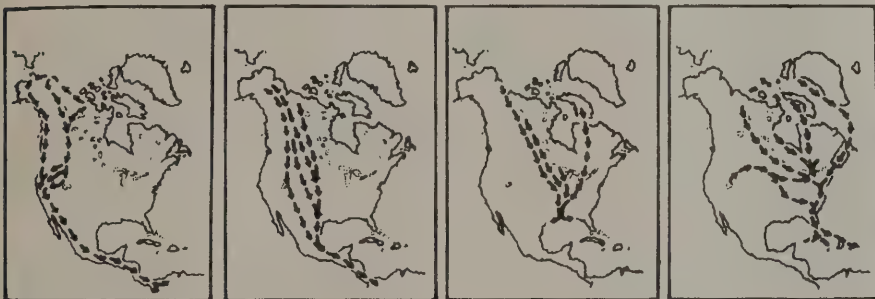




## Skyway Infrastructure

The ecostructure of airplanes can be considered an odd form of industrial bird migration. They home for fuel, to renew navigation systems (the crew), and to renew their bodies (repair). They migrate according to personnel in control towers and en route relay stations. Take-off requires personnel in the control tower with specialists in departure tracking. Orientation (compass direction) and navigation (judging position in

flight) are not just governed by the pilot. The flight plan infrastructure includes en route control centers and personnel who link and relay flight plans which adjust directions, elevations, and speed. Homing infrastructure includes pilots and specialists in approach control to balance sky and ground traffic. Collectively, these installations, equipment, and personnel form the skyway infrastructure. The sensors include eyesight, altimeters, GPS, and radar. Airplanes tend to flock at staging areas of greatest profit.



## Avian Ecostructure

The governing structure of migration starts with the planet itself. The northern realms have longer summers, for birds to forage insects and fruits, than areas near the Equator. Because few creatures live through winters, the equatorial regions have open niches for migrants to fly to.

Migration is not just a widespread rush north and south. It follows four basic flight paths (see maps above) toward richer landscapes which include a crucial ecostructure in need of conservation: the key staging areas are Alaska's Copper River Delta, Washington's Gray Harbor, Canada's Bay of Fundy, Kansas's Cheyenne Bottoms, and the beaches of Delaware Bay. The staging

areas govern food intake and flight success. Birds arrive at Delaware Bay, for instance, in time for horseshoe crab egg-laying. The eggs fuel the birds to the Arctic.

Bird migration, like long-distance airplane flying, needs orientation (compass direction), navigation (judging where you are in flight), and homing. Flight orientation and navigation rely on many types of governing structures: the placement of the sun, constellations, aerial outlines of landscapes, electromagnetic fields, ocean currents and winds, even odors. Destruction of any governing structure or any linking staging area can cause even populous species to instantly plummet.

## Avian Guards

### Institute for Bird Populations

PO Box 1346, Point Reyes Station, CA 94956-1346, 415/663-1436.

For info on bird-banding classes at stations and military camps and forts, visit: [ourworld.compuserve.com/homepages/birdbanding](http://ourworld.compuserve.com/homepages/birdbanding).

### Cornell Laboratory of Ornithology

\$35 membership includes quarterly magazine *Living Bird* and quarterly newsletter *Birdscope*. 159 Sapsucker Woods Road, Ithaca, NY 14850, 607/254-BIRD, [www.ornith.cornell.edu/](http://www.ornith.cornell.edu/).

### Cerulean Warbler Atlas Project

See Cornell Lab or [forest\\_birds@cornell.edu](mailto:forest_birds@cornell.edu).

### BirdSource

[birdsource.cornell.edu](http://birdsource.cornell.edu).

### Partners in Flight/ Aves de las Americas

[www.pif.nbs.gov/pif](http://www.pif.nbs.gov/pif).

Free newsletter *Bird Conservation* c/o American Bird Conservancy, 1250 24th Street, NW, Suite 400,



Washington, DC 20037, 888-BIRDMAG, [abc@abcbirds.org](mailto:abc@abcbirds.org).

### Ducks Unlimited

800/45-DUCKS, [www.ducks.org](http://www.ducks.org).

Ducks Unlimited has been responsible for the preservation of more water-bird breeding grounds than any government or other group.

### Crane Music

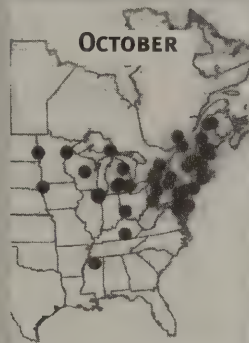
Paul Johnsgard. 1991; \$9.95. University of Nebraska Press.

### Flight of the Red Knot

Brian Harrington, Charles Flowers. 1996;

\$29.95. W.W. Norton.

Two of the best resources on the complete ecostructure of avian skyways.



Maps show irruption and invasions of winter finches from Canada (1997) as reported by bird-watchers to BirdSource, via the Internet.



# GREENWAYS, FLORAL WAYS

**M**onarch butterflies may be doing more to foster good relations between Mexicans and Americans, or at least the children, than NAFTA. East of the Rockies, hundreds of students and volunteers tag more than 50,000 Monarchs a year and track their flyways from milkweed patch to milkweed patch and then back to the old-growth fir forests of Mexico. Monarch lives are spectacular. It may take five generations to make the round trip from Mexico to the US and back. The fall migrating Monarchs are the great-great grandchildren of the Monarchs that left Mexico in the spring. In the fall, a special super-Monarch is born that may live eight months, migrating as far as 2,500 miles, overwintering in the *oyamel* fir forests near Mexico City, and then



PETER ARNOLD

A tagged Monarch with identification number and who to contact.

making the first leg of next spring's journey. The tag-team offspring that work their way north live only two to six weeks. The floral and forest ecostructure of the great circle flight includes the milkweed fields, other flowers for nectar, and the overwintering forests.

For the Monarchs that migrate east of the Rockies, the ecostructure element of prime importance is the remaining few hectares of *oyamel* fir in eleven old-growth fragments west of Mexico City. Here, sixty to ninety million Monarchs overwinter. West of the Rockies, there are 120 to 200 coastal sites from north of San Francisco to Ensenada. Many coastal sites—on prime, high-priced real

estate—are at risk. All over, the milkweeds serve as food depots for caterpillars. They have been hammered by expanding and more efficient ag-biz as well as suburban sprawl. Milkweed, considered a weed to farmers, is the energy of the Monarch's metamorphosis as well as its protective chemistry.

**Monarch Watch** is the butterfly guardian of the East; **Monarch Program**, the guardian of the West. **Watch** works with kids, getting them excited about tagging and then seeing and tracking the migration with data on the web. **Watch** sends educational materials to Mexico, but is not directly involved in finding alternatives to tree cutting. **La Cruz Habitat Protection Project** and the **Monarch Butterfly Sanctuary Foundation** are trying to start processes that will reconcile local peasants with Monarch overwintering tree protection. ⊕

## Monarch Guardians

**La Cruz Habitat Protection Project**  
*Michoacan Reforestation Fund*, 260 Mather Street, Oakland, CA 94611, 510/658-6758, danaus@pacbell.com.

**Monarch Butterfly Sanctuary Foundation**  
2078 Skillman Avenue, Roseville, MN 55113, oberhoo1@tc.umn.edu, www.indynet.com/~burfish3/mbsf/mbsf.htm.

Mexican Monarch overwintering grounds sit on land communally owned by peasant families. The *ejidatarios* do not want to sell it, and believe they were inadequately compensated when the government created preserves and limited logging—their chief source of income. The **Sanctuary Foundation** will provide incentives for decreasing the number of trees cut in the butterfly preserve in the form of support for economic and educational development, including funds for reforestation, craft-making, and eco-tourism projects; training guides and researchers; and school-based programs. **La Cruz Project** offers trees grown

from locally collected seeds for reforestation at lower elevations as one incentive to stop cutting in the butterfly forests.

**Monarch Watch**  
\$12 membership includes annual season survey. C/o O.R. Taylor, Department of Entomology, Haworth Hall, University of Kansas, Lawrence, KS 66045, 888/TAGGING, 785/864-4441, monarch@ukans.edu, www.MonarchWatch.org. Migration patterns poster available for \$15.

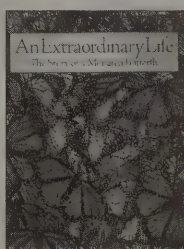
**Monarch Program**  
\$25 membership includes monthly Monarch News. PO Box 178671, San Diego, CA 92117, 800/606-6627, 760/944-7113, fax 760/436-1159, Monarchprg@aol.com.

**The Monarch Habitat Handbook**  
\$3 postpaid. *The Xerces Society*, 4828 Southeast Hawthorne Boulevard, Portland, OR 97215.

Best info and contacts for protecting West Coast overwintering habitats.

## An Extraordinary Life

The Story of a Monarch Butterfly



Laurence Pringle. 1997; 64 pp. \$18.95 (\$20 post-paid), 20% discount for schools and libraries. Orchard Books, 93 Madison Avenue, New

York, NY 10016, 800/621-1115, 212/951-2600, fax 212/213-6435.

## The World of the Monarch Butterfly

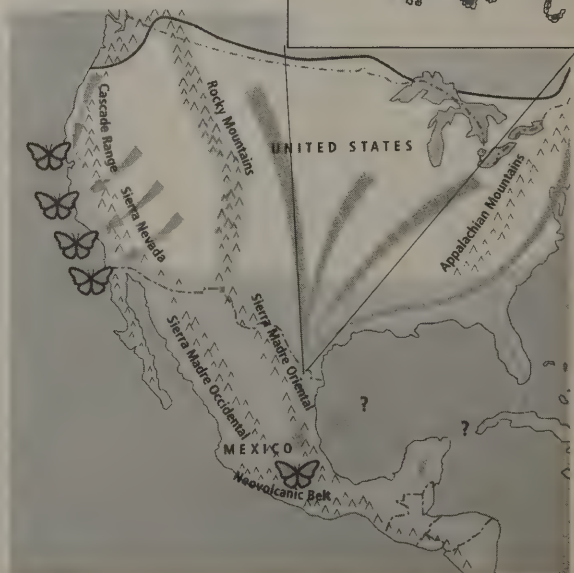
Eric S. Grace. 1997; 114 pp. \$27.50. Sierra Club Books.

**Extraordinary** is a children's book that doesn't write down to its readers. **World** has the more detailed scientific information, and Sierra Club-quality photography.



Below: Monarch Butterflies show location of wintering grounds.

Right: Overwintering groves of Eastern Monarchs.





# AIRWAYS AND FUELING STATIONS

The ecostructures of bats are as various as their 925 species. For survival, these governing structures need to be intact: caves for roosting and maternity colonies; dense forests with lots of branches to cling and hang from, with protection from raptors; and nectar "fueling stations" arrayed at proper distances in order to fill up between summer and winter homes. Maintaining and conserving bat ecostructure can be quite a chore, especially as the emotional structure of citizens tends to be chock full of fear, lumping all bats as rabid vampires.

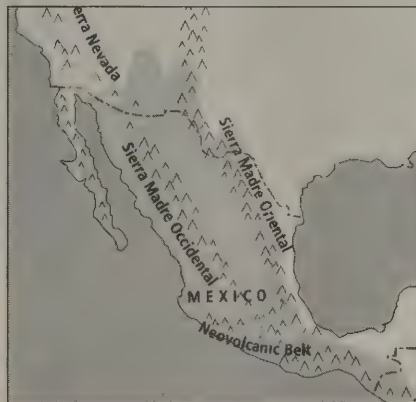
**Bat Conservation International** (Millennium Catalog, p. 51) is the excellent ambassador between Mexico, the US, the public, and bats. Its international program focuses on insectivorous Mexican free-tailed bats and nectar-feeding long-nose bats. Mexican free-tails migrate between Kansas, Arizona, and the Southeast for summer birthing and back to Mexico for winter roosts. Their roosts and maternity colonies (caves and sometimes trees) are the endangered components in these bats' lifecycle. The skyways seem safe. Similarly,

PAUL MIROCHA



Above: Saguaro cactus blossom: fueling station in early summer for long-nose bats. Below: In summer, two

species of long-nose bats head north. They overwinter in Mexico, fueling on agave flowers.



will be the first, with trained high school students as the first steward/interpreters, guiding visitors and guarding against vandalism and other disturbances. **PCMM** is starting the grand task of educating Mexico to the benefits of insectivorous bats that help control agricultural pests—and teaching proper perspectives on vampire bats—with children's books, radio programs, and community education. Bats couldn't have better allies than this cooperative infrastructure to save their ecostructure. Bilingual educational materials available. ☉

**Migratory Bat Conservation Initiative / Programa para la Conservación de Murciélagos Migratorios de México y Estados Unidos de Norte America (PCMM).**  
*Bat Conservation International. \$30 annual membership, PO Box 162603, Austin, TX 78716, 512/327-9721, www.batcon.org.*

# BLUEWAYS AND RIVERS

The governing structure of salmon starts in a free-energy, input-rich headwaters stream where small packages of food drop from the sheltering and shading old tree architecture. The smolts migrate downstream, transforming from freshwater to salt fish, and then live in the open sea, devouring increasingly larger packages of food and structuring their lives by currents and upwellings. Then they return from salt to freshwater, climbing to their home watershed to mate and spawn. They do this fasting, returning their own bodies to the nutrient of the stream. The complete linked stream/sea/stream is its ecostructure. ☉

Every aspect of salmon ecostructure has been altered by human infrastructure. Their passage has been blocked by reservoirs (1), diversion dams (7), erosion dams (10), and navigation and re-regulation locks (18, 19). The streams have been depleted by industrial and drinking water supply (4) and irrigation (6, 8, 11, 13, 14, 16).

The channels have been damaged by clearing (10), channelization (7), and pollution (17) that destroys homing signals. Fish farm salmon (20) have swamped the wild genes of more migratory species. Salmonid restoration, if it occurs, will transform both the infrastructure of river basins and the law of the seas.



**The Salmon Page**  
[www.riverdale.k12.or.us/salmon.htm](http://www.riverdale.k12.or.us/salmon.htm)

Salmon supporters are legion and trying hard against a huge array of special interests. Salmon are Big Business and Big Sport. This web page, from an enterprising Oregon middle school, is a good place to start.

**Pacific Salmon Commission**  
 1155 Robson Street, Suite 600, Vancouver BC V6E 1B5, 604/684-8081, [www.psc.org](http://www.psc.org)

Migrating salmon pass through US waters on their way to Canadian rivers, and vice versa, creating the major North American cross-border migration quandary. **PSC** gathers federal, state, provincial, and native representatives in search of an equitable resolution.





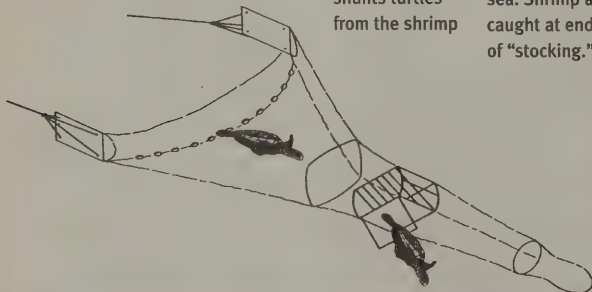
# BLUEWAYS AND BEACHES

Except for the loggerhead, all species of sea turtles in US waters are endangered (Kemp's ridley, hawksbill, green, and leatherback). Their survival depends on many nations. Blueways (deep water and off-shore continental shelves for feeding, mating, and estivating) and beaches for egg laying are the governors of their survival. Connect safe blueways and beaches together and you have the ecostructure of turtle heaven. Here's hell:

**Beach damage:** Harvesting for eggs, meat, oil, jewelry, souvenirs; blocking or deconstructing nesting grounds (e.g., development; beach "nourishment" by burial and foreign sands; vehicles; sea walls, rock revetments, and erosion); ruining homing to the sea by lighting; "save the turtle" tourists who carry hatchlings to the water before they imprint on the beach.

**Deep water threats:** Currents gather and concentrate pollutants, flotsam, and jetsam (trash from boats and beaches, fishing lines, plastic bags which turtles mistake for jellyfish); trawling by shrimpers not using Turtle Extruder Devices (TED). ⊕

A turtle extruder shunts turtles from the shrimp net and back to sea. Shrimp are caught at end of "stocking."

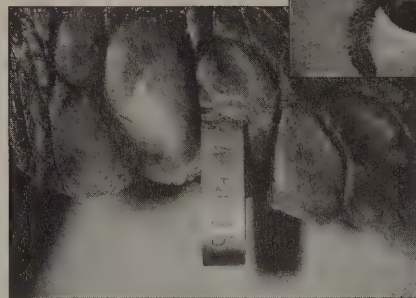


## Caribbean Conservation Corporation/Sea Turtle Survival League

\$25 membership includes quarterly *Velador*. 4424 NW 13th Street, Suite 1-A, Gainesville, FL 32609, 352/373-6441, fax 532/375-2449, ccc@cccturtle.org, www.cccturtle.org.

CCC/Sea Turtle Survival League, based in Florida and Tortuguero, Costa Rica, responds with citizen science programs; educa-

tion aimed at residents, tourists, and fishers; lobbying to create and expand preserves, enforce TED and gill net regulations, stop harmful roads, and ban sea turtle trade. CCC supports local efforts to create a tri-partite turtle conservation agreement among Panama, Costa Rica, and Nicaragua, to promote protein alternatives to turtle meat, and to develop other income for turtle hunters.



## Sea Turtles

Jeff Ripple. 1996; 84 pp. \$16.95 (discount for direct order and prepayment). Voyager Press, Inc., 123 North Second Street, PO Box 338, Stillwater, MN 55082, 800/888-9653, fax 612/430-2210.

This one goes on our shelf right next to Archie Carr's classics, especially *The Sea Turtle: So Excellent a Fishe* (Millennium Catalog, p. 49). Unless your heart's as hard as carapace, this book's a prelude to turtle love, with page after page of spectacular photographs. It's a solid introduction to all eight remaining species, and to the sea turtle odyssey from the beach-scramble of fifty-cent-sized hatchlings to "lost years" in the deep sea to the return of the three-hundred-pound adult to lay eggs on the same beach where she was hatched. Our one disappointment: no maps. —MKS

“ A number of factors can affect whether or not a turtle will complete nest construction and begin laying eggs. Many turtles emerging from the water, ascending the beach, or digging a nest cavity may turn back if they are bothered by lights or by unusual activity on the beach. Some turtles will abandon a nest site if they encounter a root, rock, or other obstacle, or if the sand does not have the correct consistency or moisture content. Other turtles may nest regardless of what is going on around them. If a turtle fails to nest and returns to the sea from the beach without laying her eggs, it is referred to as a "false crawl." The percentage of false crawls varies among species, among populations within a species, and even among individuals within specific populations.

Top: A radio transmitter will track the turtle's migration by satellite. Middle: A turtle tag, used to see which beach it returns to. Bottom: Green turtles mate at sea. Right: Map of green turtle migration from egg-laying beaches.





# BLUEWAYS & LAGOONS

It is the structures of the deep sea and shallow lagoons and nearshore ice that govern whale existence—over thousands of miles of ocean.

For instance, gray whale birthing lagoons need regulated tourism and a stop to a huge salt refinery to keep their nurseries intact. ⊕



## Cetacean Savers

### Cetacean Society International

PO Box 953, Georgetown, CT 06829, phone/fax 203/544-8617, elfnet1a.elfi.com/csihome.html.

The global group working against outlaw whalers and for driftnet management, whale sanctuaries, and pollution control.

### Animal Welfare Institute/ Save the Whales

PO Box 3650, Washington, DC 20007, 202/337-2332, fax: 202/338-9478, www.animalwelfare.com.

The PR firm for cetaceans. Opposes commercial whaling

and monitors the International Whaling Commission.

### Sea Shepherd Conservation Society

PO Box 628, Venice, CA 90294, 310/301-7325, fax 310/574-3161, www.seashepherd.org.

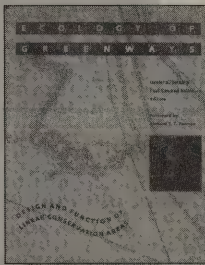
The only good cops on the open seas, placing their lives between whale and whaler (see photo, left).

## Ecology of Greenways

### Design and Function of Linear Conservation Areas

Daniel T. Smith and Paul Cawood Hellmund, editors. 1993; 222 pp. \$39.95. University of Minnesota Press.

Not so long ago huffy academics would question me: "How can you do both wildlife and water consulting. Aren't they different?" Finally, a book that understands landscape integrity, that designs for different intensities of human occupation, and tries to use our embryonic state of scientific knowledge about landscape ecology with care. Linear and mosaic greenways, blueways, skyways, and florid butterfly ways all need immediate attention. This is the single most important book in this issue for ideas and design on tomorrow's landscapes, especially the essay by Reed Noss and the case studies. —PW [Suggested by Atty Mullens.]



“ Dispersal can occur between fragments and forestall extinction of sensitive species on a regional scale...influenced by the configuration of the fragments and the landscape mosaic in which they are embedded. Conservationists would do well to expand their view of what constitutes connectivity for various species rather than restricting themselves to the notion of distinct linear corridors. —REED F. NOSS

“ In addition to proposed development, animals along the Wekiva [a river on the fringes of Orlando] are threatened by several major roads that bisect the area. To allow bear and other animals to cross the road in safety, two underpasses have been proposed at the most frequently used and dangerous locations. Bear tend to cross where there is continuous cover on both sides...When the underpasses are built, existing wooded corridors will be maintained to guide the animals to the underpasses. A 10-foot high chainlink fence will be erected along the length of the road with breaks at the underpasses...there are no immediate plans to construct these underpasses. —DANIEL S. SMITH

## Greenways Guidance

### Creating a Statewide Greenways System

For People...for Wildlife...for Florida. Florida Greenways Commission. 1994; 186 pp. PO Box 5948, Tallahassee, FL 32314-5948; 850/222-6277, fax 850/222-1117.

Cutting-edge model for a wrecked bioregion.

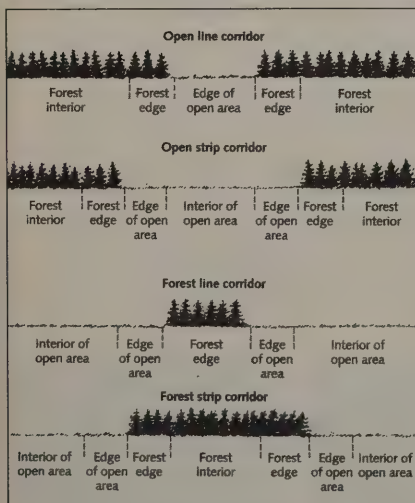
### International Association for Landscape Ecology

US Regional Association, US-IALE, Appalachian Environmental Laboratory, Gunter Hall, Frostburg, MD 21532, 301/689-3115, fax 310/689-8518, www.edc.uri.edu/iale.

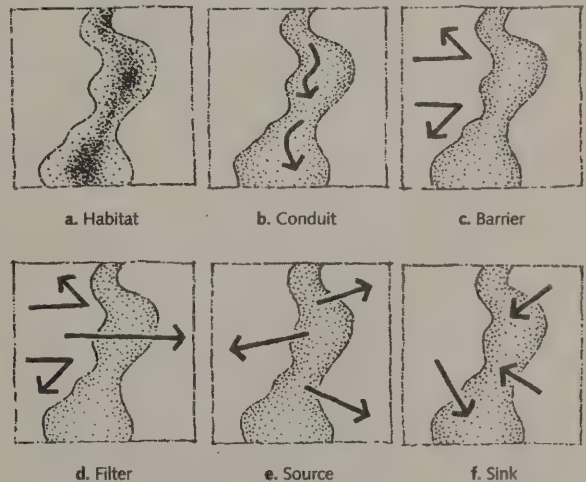
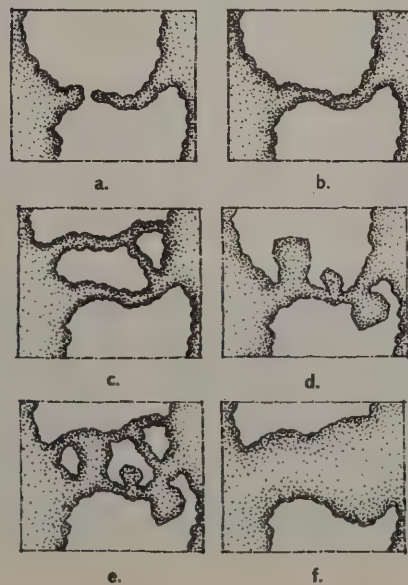
500 scientists and land managers have joined together to look at the big picture of land mosaics, to evaluate relationships between pattern and process at landscape scales, and to create useful models. Members receive discounts on the annual symposium and subscriptions to the journal, *Landscape Ecology*.

### Greenways

*The Beginning of an International Movement.* Julius G. Fabos and Jack Ahern, editors. 1996; \$228.50. Elsevier Science. The encyclopedia. The necessary read from your local library.



Line corridors, which are edge habitat, and strip corridors, which contain both edge and interior habitat, can be either forested or open, depending on surrounding matrix.



Left: Options for corridor and network structure. Basic concerns are avoiding breaks (a), and establishing a continuous bridge (b). Redundancy (c)

provides alternative movement corridors, whereas nodes (d) provide dwelling habitat at intervals along corridors. Redundant links and nodes

can join to form a habitat network (e), but broadstrip corridors (f) provide best protection.

Above: The six basic corridor functions.





# sapsuckers at work

By hewing nest holes in aspens and tapping sap from willows, a keystone bird restructures a mountain landscape, composes its species list, and connects its community members.

**PAUL EHRLICH  
AND GRETCHEN DAILY**

**A**t first it seemed nothing could be more fascinating about red-naped sapsuckers than their construction of flowing “wells” in the bark of shrubby willows and the over forty birds, mammals, and insects that crowd into the shrubbery to gorge on the willow’s sugary sap. Curiosity drove us to spend months in sapsucker habitat, crawling through the willow thickets for miles around, enduring persistent clouds of mosquitoes and biting flies, to film and take data on well robbers, plotting endlessly to outsmart and capture wily sapsuckers and chipmunk visitors, and generally driving our friends crazy with daily sapsucker stories. Instead of satisfying our curiosity, this work further intensified our interest in the sapsucker as a double-duty keystone species and a major architect of willow/aspens groves.

A keystone species is one whose removal from the community would precipitate a further reduction of species diversity or produce significant changes in the community structure. One of the most intriguing keystone mysteries was whether or not other species really depend upon the sapsuckers. The visitors to sapsucker wells may benefit substantially from exploiting the rich sap resource, supplied when many are breeding and then storing fat for the winter’s migration or hibernation. However, most of those species eat highly omnivorous diets, making it difficult to determine exactly how much their populations would suffer were the sapsucker, and hence the sap

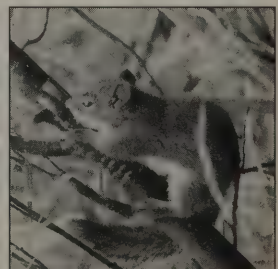
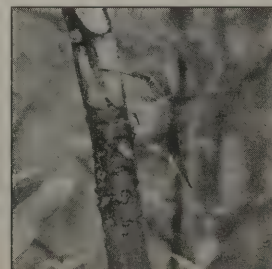
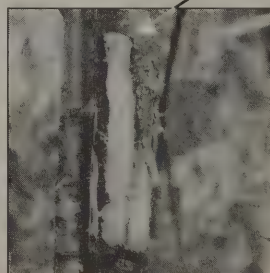
resource, to disappear. This mystery led us to a second: whether the sapsucker’s lifestyle—the excavating of nest holes—benefits a second suite of species.

In the vicinity of the Rocky Mountain Biological Laboratory in Gunnison County, Colorado, there are moist meadows largely surrounded by quaking aspen groves and scattered Engelmann spruce. Approximately one-half of the meadow surface is occupied by dense patches of three species of shrubby willow about six to nine

feet in height. A sapsucker pair drills a new nest hole each year in an aspen infected with heartwood fungus. Of thirty-six active sapsucker nests in the area, only one was situated in an old hole (a hole that had been excavated the previous year). We tracked the occupancy of old holes and found seven different bird species raising their young in them: tree swallows, violet-green swallows, house wrens, mountain bluebirds, mountain chickadees, northern flickers, and a Williamson’s sapsucker pair.

We found that red-naped sapsuckers create at least ten times as many nest holes as any of the less common woodpeckers (e.g., the hairy woodpecker). Since a shortage of nest holes may limit the population sizes of species incapable of creating their own cavities, we suspected that the presence of sapsuckers might be vital to these secondary cavity nesters. How could we find out whether the sapsuckers were indeed crucial to the others?

Back in the 1950s, biologists would have simply shot all the sapsuckers to see whether the populations of other bird species would change as a consequence. Fortunately, the times have changed, and such brute-force approaches are now rightly





condemned. We sought an indirect method that, with luck, would give us the answer. Our strategy involved first identifying a critical feature of habitat required by the sapsuckers themselves. Then, we planned to compare the bird communities in habitat patches with and without that one feature, and thus with and without sapsuckers. This would allow us to infer the effect of removing the sapsucker.

Sensing that all of this would require a lot of work, we enlisted the enthusiastic help of Nick Haddad, a Stanford honors student with experience in censusing birds.

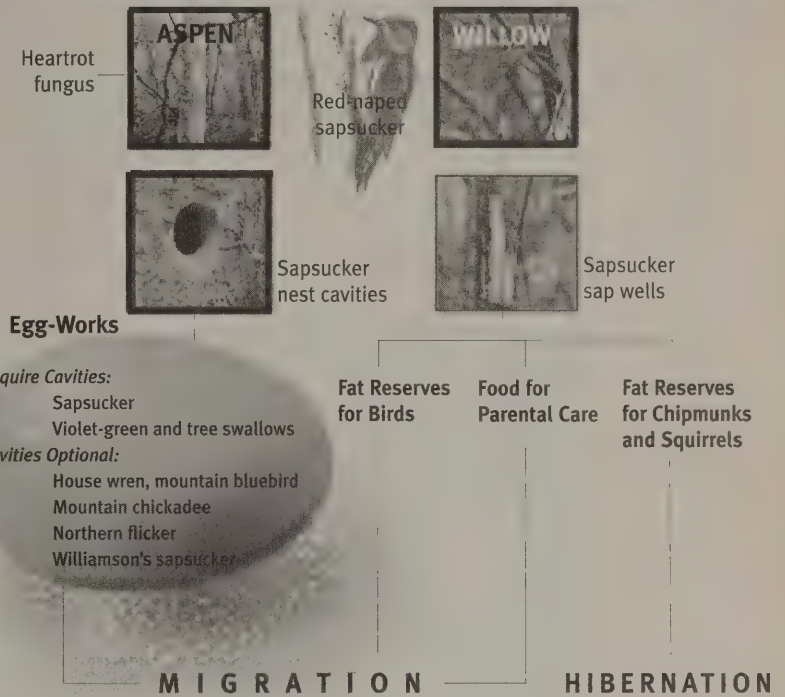
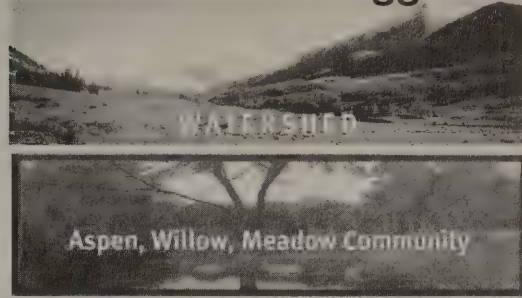
The most obvious candidate for a critical habitat feature for supporting sapsuckers seemed to be the proximity of suitable willow shrubs (for drilling sap wells) and aspen (for nesting). Our working hypothesis was: the sapsucker would not occur in areas lacking in either willow or aspen. To test this, we surveyed over 13,000 aspen trees located at varying distances from willow shrubs for signs of sapsucker wells. Sapsuckers drill wells into aspen early in the breeding season; the damage they cause remains distinctive for at least ten years, providing an indication of habitat occupied by sapsuckers.

Indeed, we found that as many as thirty-five percent of the aspens in very close proximity (fewer than fifteen meters) to willows bore sapsucker damage, whereas fewer than five percent that were far (more than 1000 meters) from willow did. Not only was there much more damage on trees close to willow, there were also more nest cavities. In general, we couldn't attribute a nest cavity to any particular primary cavity nester. However, the high prevalence of wells drilled around the nest trees suggested that many were created by sapsuckers.

We also surveyed willow clumps situated close to and far from aspen for signs of damage. Here again, we only found sapsucker damage in willows close to aspen. Willows near large spruce stands or in open, treeless mountain meadows bore no damage at all. Sapsuckers were only present in areas with both willow and aspen.

This provided an ideal way to test the importance of the sapsucker to other birds. We established census plots of five and two-tenths hectares (about thirteen acres) in six aspen groves, three near willow (less than twenty meters) and three over one

## The Ecostructure of Egg-Works



kilometer away from the nearest willow shrub. Then, for the next six weeks, the three of us spent each early morning censusing the breeding birds in the plots. Other than the proximity of the willow, the aspen groves were selected to be as similar as possible. We found out, for example, that it was possible to be bitten and sucked dry by voracious mosquitoes in a matter of minutes at all sites. It was certainly encouraging that insect populations seemed able to support a rich community of avian insectivores at each site.

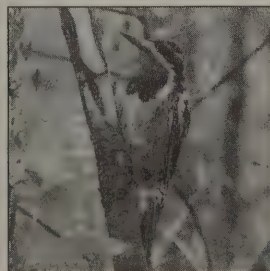
As we predicted, sapsuckers were only present in the three sites close to willow. Interestingly, we found both violet-green and tree swallows only occur at the three sites which had sapsuckers. A

statistical test showed that the chance of this swallow/sapsucker association being purely coincidental was vanishingly small. Tree swallows virtually always nest in cavities, and while violet-green swallows are known to nest in cliffs, no such opportunity was available at any of our sites.

All of the other secondary cavity

Above: Just as a waterworks's long-term impact is on drinking water, the long-term impact of this community is reliable and abundant eggs. The sapsucker is the major governor of the egg-works, along with aspen, willow, and heartrot fungus.

Drinkers of sweet willow sap from the "well" drilled by a sapsucker. Left to right: the well itself; rufous hummingbird; red squirrel; vespid wasp; orange-crowned warbler; adult sapsucker.





nesters were present in each of the six sites. They were generally more common in the sapsucker sites, however. Their abundance in the non-sapsucker sites (far from willow) seemed to depend upon the availability of alternative nesting locations. So, for example, we found many house wrens in sites littered with fallen, rotting logs, a favorite non-cavity nesting location, and no house wrens at all in a non-sapsucker site without fallen logs.

It thus seemed that the sapsuckers could be quite important in the persistence of secondary cavity-nesting birds. But how could we be sure that the absence of swallows and the lower abundances of other secondary cavity nesters in non-sapsucker sites were not due to some other factor? Perhaps there happened to be less food in the non-sapsucker sites. The swarms of insects present at all sites made that possibility seem unlikely, but such anecdotal evidence is not very admissible in science. That's why we also censused species of insectivorous birds that were not hole-nesters.

We found that open-nesting insectivorous birds occurred in roughly equal abundances on all sites. Most sites had five to six pairs of dark-eyed juncos, two to four pairs of American robins, one to two pairs of hermit thrushes, three to six pairs of warbling vireos, and a couple of pairs of yellow-rumped warblers and western wood-pewees. The western wood-pewee forages aerially upon insects, somewhat like swallows, making it unlikely that the insects, rather than nest cavities, explained the presence or absence of the swallows.

### In Conclusion

First, we found that swallows, and to a lesser extent, the other secondary cavity nesters, depend upon the co-occurrence of at least four elements of what we have called a keystone species complex: the red-naped sapsucker, aspen trees, certain willow species (in which the sapsuckers can drill sap wells), and the heartwood fungus. The disappearance of any one element could result in the local extinction of the two species of swallows and declines in the populations of the other secondary cavity nesters. Second, the sapsucker has the unusual characteristic of playing two distinct keystone roles: enhancing the persistence of both sap-robbers and cavity nesters. Third, the sapsuckers modify the forest/meadow community by changing the survival rates and dimensions of the willow clumps

and, perhaps, the aspens. The sap wells eventually cause parts of each willow to die and may restructure the willow clumps more than browsing by all the other mammals. Similar wells drilled in aspen as well as the holes chisled into the aspen trunks may alter their survival and patchiness.

Finally, while the tropics have classically been thought of as supporting species with complex, indirect, and subtle interrelationships, this work suggests that such interdependencies may be common in the temperate zone as well. Saving a species may therefore depend upon the persistence of another species with which it has no direct interaction. Like the sapsucker, a keystone species can modify a patch of environment, making it suitable for the reproduction and food supply of other species. Put another way, the already blinding rate of extinctions may accelerate even more because of this domino effect of harm to one species having unknown and multiple impacts throughout a whole community. Despite this somewhat disturbing conclusion, this work inspires us to delve deeper and deeper into sapsucker biology. ⊕

Paul Ehrlich is an awesome combination of maniacal naturalist, prolific writer of books and articles, and conservation activist. The name of our earlier incarnation, *CoEvolution Quarterly*, was essentially inspired by Paul. We have reviewed his books, from the society-changing *Population Bomb* to *Birds in Jeopardy*, for twenty-five years. His awards are too many to list. He surpasses sixty-something years, but I know of no other biologist who can hike as strong and name butterflies and birds as fast.

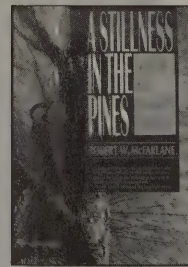
Gretchen Daily is the editor of *Nature's Services* (see review, p. 15), Bing Interdisciplinary Researcher in the Department of Biological Sciences at Stanford, and a major voice in connecting biology, equity, conservation, and futures for the Earth.

### A Stillness in the Pines The Ecology of the Red-Cockaded Woodpecker

Robert W. McFarlane.  
1994; 270 pp. \$10.95.  
W.W. Norton.

This is the best natural history of a tree cavity excavator whose work provides the forest with additional housing for insect pest-control species and free seed-dispersal services. Unfortunately, like its biggest cousin, the ivory-billed woodpecker, the red-cockaded appears to be slowly heading down the bumpy road toward extinction. McFarlane writes stolid prose, and every sentence tells more detail of his primary love (the life of the bird). But each chapter also reveals the bio-politics of the Forest Service; how information, no matter how complete and fascinating, will not budge this irrational bureaucracy nor the camaraderie of its petty agency politics.

Naturalist, witness, advocate. We need hundreds more. —PW



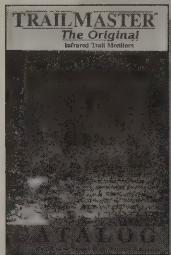
“Cavities provide roosting holes, a nesting location, protection from predators and inclement weather—in other words, a useful home. But if the cavity provides these services to the excavator, could it not also provide them to the denizens of the forest? The red-cockaded woodpecker may be the only species with the fortitude and determination to excavate successfully in living pine trees, but once a cavity has been created, don't less capable species covet it as well? Indeed, they do....Hundreds of species worldwide observe the excavation process with acquisitive intent and avail themselves of the first opportunity to dispossess the excavator. New cavities are particularly in demand, for they are clean and free of nest parasites and other vermin.

“The red-cockaded woodpecker has survived raging forest fires and rapacious timbering at the turn of the century. It has evolved a symbiotic relationship with the red heart fungus and an effective defense against arboreal snakes. It has survived episodic losses of its cavity trees and timber resources to southern pine beetles. Can it survive stewardship with the Fish and Wildlife Service and Forest Service?



# TRAILS

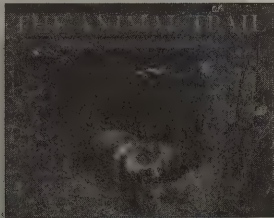
Movement on land leaves traces, and the traces become easier paths for anybody in the neighborhood, and soon the footprints have compacted the earth and the plantlife has been shaped for safe passage and the air is full of odoriferous information and the complete ecostructure more connective and resistant to change. In the Brooks Range of Alaska, an old grizzly trail has left paw prints in granite. We would need a whole issue to deal with the deer path becoming the human trail and so on to super-highway. Here's a page for animals. See page 23 for greenways and page 60 for metro-forests. —PW



## The Animal Trail Four Seasons of Wildlife Photography

Manabu Miyazaki. Out of print (formerly published in 1988 by Chronicle Books).

Help us rectify this dire situation: appeal to your favorite publisher to get this unparalleled book back in print. Beautiful four-season photos of different animals in transit on their quiet Japanese Alps highways.



## TrailMaster Infrared Trail Monitors

Catalog from Goodsen & Associates, Inc., 10614 Widmer, Lenexa, KS 66215; 800/544-5415 or 913/345-8555, fax 913/345-8272, www.trailmaster.com.

Whether attempting to photograph a rare or shy species or documenting animal movements on trails, TrailMaster monitors and cameras and a variety of accessories (e.g., video cameras) provide exciting options for non-intrusive snooping on

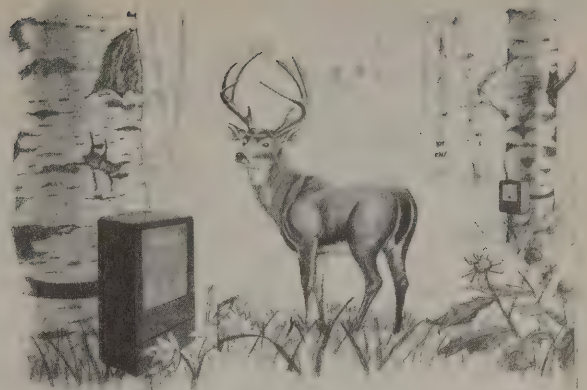
who's using a trail. In southeast

Arizona, the Game and Fish Department, in conjunction with the Malpai Borderlands Group, has collected hundreds of photos using the infrared Trail Monitor 1500 with a remote camera setup. The study documents movement of large predators (bobcats and mountain lions) and has provided a lengthy list of

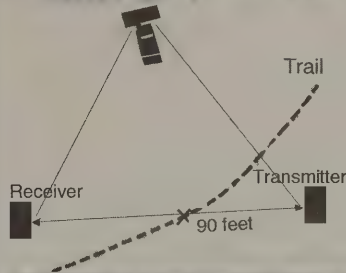
other animals using the same trails, including wild turkeys, javelina, coyotes, and *chulos*. It's suspected that ringtail cats and jaguars also roam these trails.

The setup is simple, with the invisible beam crossing the trail. The camera is placed twenty feet away and positioned to photograph the entire section of trail that the beam spans. A data collector unit records the date and time of each event while the camera is programmed not to shoot another photo until a certain amount of time has lapsed. This delay can be set for six seconds to ninety-eight minutes and prevents the entire roll of film from being shot on one curious creature. The whole system can be set up in less than an hour and runs for thirty to ninety days on C-cell batteries. A great tool! Have fun!

—Jeffrey Caspary



Setup to photograph wildlife on a trail. Camera is 20-25 feet from receiver-transmitter line.



A *coati mundi* (neotropical relative of the raccoon), also called a *chulo* in Spanish, photographed in Arizona. Note transmitter at right.

Below, left to right: Mountain lion with head wound at same location as the *chulo*; man and Japanese raccoon dog photographed at the same spot on trail.

ARIZONA GAME AND FISH DEPARTMENT



ARIZONA GAME AND FISH DEPARTMENT



MANABU MIYAZAKI, THE ANIMAL TRAIL





# Deadwood: From the Forest to the Sea

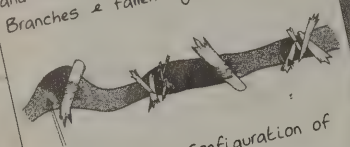
**T**HE PRESENCE OF DEAD WOODY DEBRIS—pine needles, twigs, branches, logs—supplies a movable feast in watershed ecosystems. Not just wood as food, but wood as an architectural presence, enriches life. **From the Forest to the Sea** is the keystone book, a must-read for all those trying to argue for saving wooded riparian corridors or thinking about how the dead support the living. Herein are the essentials of ecostructural thought (though the authors do not use that word). We see the grand connection of headwaters to main-

stem to estuary to sea. The changing composition of the woody material is remarkable as it helps govern a host of domains: food and nesting; “housing” opportunities; escape and refuge sites; solar radiance in the headwaters; health as a “rubbing post” for creatures in the open sea; water-flow volumes and speeds; streambank and shoreline protection, and more. There are many woody configurations, from debris dams to log slicks. All nurture life for multiple communities.

The stream channel splits, creating more patchiness and various styles of pool, riffle, and eddy. Debris acts as a series of mini-dams, slowing flow and saving fish the energy required to stay in place. The jumble of debris serves as in-stream refuge, governing survival of insects and fish.

As the debris and deadwood enter larger tributaries and mainstem, textures change: biofilms of microbes & algae cover them, adding food & sculpting log surfaces, which increases the sheltering capacity for stoneflies and others. Strands of debris shelters & hides small mammals, aiding their survival.

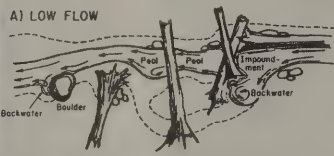
Litter, needles, cones, twigs, bark, and rootwads enter the stream flow. Branches & fallen logs create backwaters & pools. Configuration of stream patches increases.



## Headwaters

The log jam ecostructure, by holding back streamflow, lengthens the season of above-surface flow & lifespan of aquatic foodwebs.

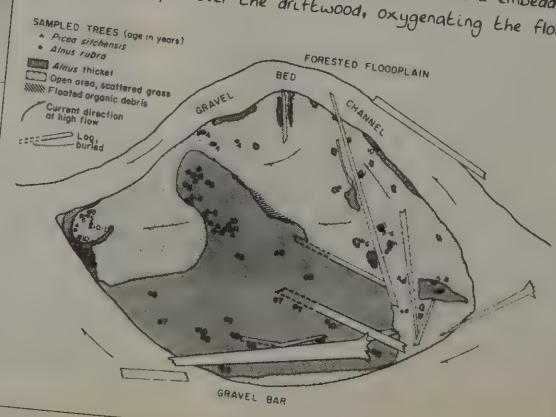
A) LOW FLOW



The ecostructure of the headwaters includes a closed canopy. The architecture shades the stream (governs the penetration of solar radiation), stabilizing the cool temperatures required by fish such as trout. Overhanging and streambank trees and shrubs supply food.

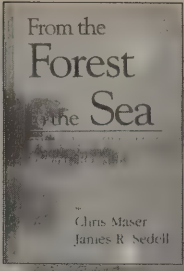
## Mainstream

Debris and driftwood change the configuration of the stream. Side channels may become blocked, forcing back-up and overflow channels. Isolated pools develop behind embedded logs. Rapids spill over the driftwood, oxygenating the flow.



SAMPLED TREES (logs in years)  
 ▲ *Picea sitchensis*  
 ● *Alnus rubra*  
 ■ *Alnus* thicket  
 □ Open area, scattered grass  
 ▨ Floated organic debris  
 → Current direction of high flow  
 ○ Log buried



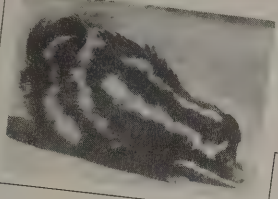


**From the Forest to the Sea**  
**The Ecology of Wood in Streams, Rivers, Estuaries, and Oceans**

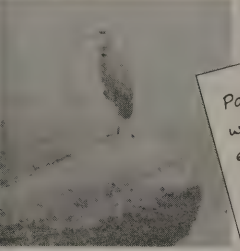
Chris Maser and James R. Sedell. 1994; 200 pp. \$65.  
 St. Lucie Press, 100 E. Linton Blvd., Suite 403B, Delray Beach, FL 33483, 407/274-9906, fax 407/274-9927.

There's a lot to mull over in this book, and also every time we pass a heap of graying driftwood piled up between the river and the tide. — PW

Logs become heavier as hollow spaces fill with water and sand. Estuarine log piles are an architecture that hides skunks & rodents and provides perches upon which herons, eagles, and cormorants can rest & eat.

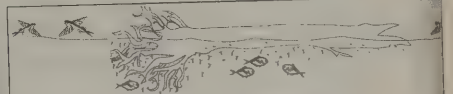
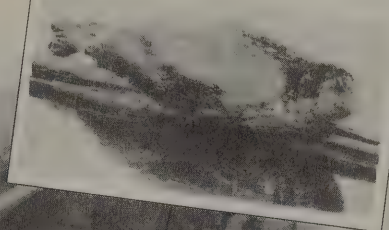


embedded in banks serve perches for birds as well as nesting locales.



Partly submerged, wood provides the egg-attachment surface for fish such as herring which, in turn, feed a host of other species.

Floating logs serve as haul-out & rest areas for harbor seals.



Zooplankton (floating animals), small fish, and their predators concentrate around rafts of drifting wood, the next-to-last formation in deadwood ecostructure. The solid surface of wood is the only place in open sea for egg attachment (for sea striders, fish, and other invertebrates). Biofilms on the wood's surface provide food. The surfaces help maintain health of cetaceans and others when used as rubbing posts to eliminate external parasites.

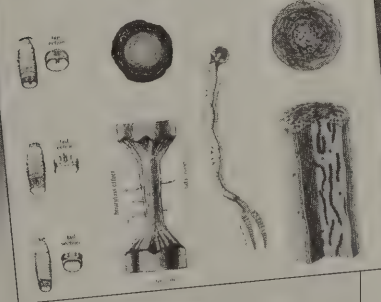
**Coastal Sand Dunes**

**Estuary & Tidal Flats**

**Open Sea**

**Deep Sea**

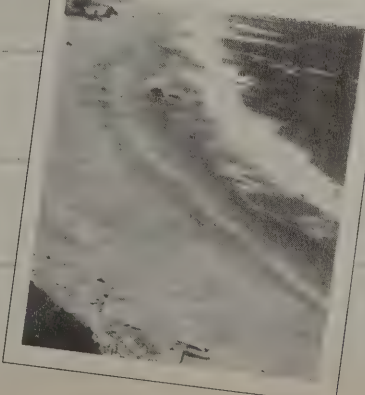
Composition of driftwood ecostructure changes as shipworms and gribbles eat out cellulose. Their fecal pellets add to estuary nutrient.



Submerged branches & logs hide young resident (stickleback) & migratory (salmon) fish from predators.

Deadwood is at the heart of the estuary foodweb, linking species and governing the flows of flesh. The configuration of the estuary alters as logs create eddies & riffles and redistribute sand & silt.

The jumbled configuration of logs on the shoreline "armors" the beach from tidal and storm erosion.



Sinking of logs is the last event that governs shelter & food sources for creatures in the deep. The final deconstruction of woody debris is poorly known.



# Beavers

Beavers' dams govern water flows in watersheds; govern the community of species by providing different homes and foods; govern the speed and extent of forest change within 200 to 300 feet of their ponds; govern the mosaic of pond, meadow/marsh, and forest communities; and govern the wandering of wolves who hunt the beavers. In some watersheds, there can be hundreds of beaver ponds or beaver meadows and, according to early pioneers and beaver believers, a completely more sparkling American landscape.

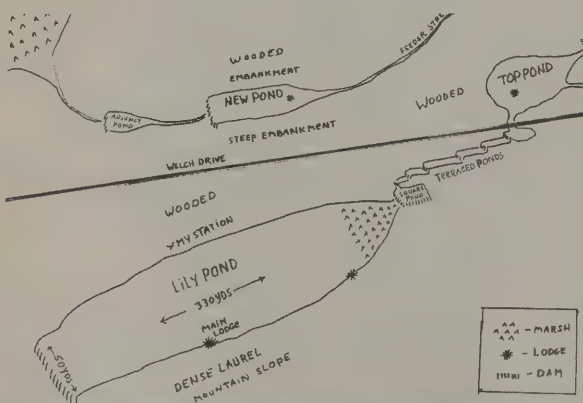
Hope Ryden writes in *Lily Pond*:

“Beaver-made ponds appear and disappear cyclically, and the places we inspected were of great interest to both of us. They looked like beaver ghost-towns and appeared to have been occupied and abandoned more than once. That is the way of the species. *Castor canadensis* is nature's agent for renewal; the creature's

appearance and disappearance create drastic alterations in a place, forcing old tired systems to yield to entirely different complements of plant and animal life. A new beaver pond serves a broad spectrum of aquatic species—otters, muskrat, mink, ducks, fish, turtles, frogs, wading birds—and continues to do so for as long as it is surrounded by a substantial number of the beaver's preferred food trees. When these are used up, the colony moves on, its forsaken dams break, and the pond drains. Then the rich mucky bottoms of what once were beaver waterworks give rise to an entirely different type of vegetation. Meadow plants take root and grow and these support a new array of animals, deer and voles and rabbits, which, in turn, become the food base for land predators, foxes, bobcats, coyotes, weasels, hawks.

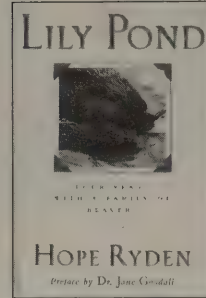
It is not difficult for a practiced eye to recognize that a particular meadow arose from the fertile sediment left by repeated beaver habitation. But as time passes, this lush meadow gives way to yet another biotic system. It is colonized by trees, the first to pioneer being willow, birch, and aspen—species the beaver relishes. As the forest matures, beavers once again return and turn the place into a pond. First they dam what

A map of the ecostructures and landscape created by the *Lily Pond* beavers in Harriman State Park, New York.



## Lily Pond Four Years with a Family of Beavers

Hope Ryden. 1997; 258 pp. \$16.95. Lyons & Burford Publishers, 31 West 21 Street, New York, NY 10010, 212/620-9580.



Hope Ryden is the most eloquent of beaver bards. Hers is the only recent text to weave patterns of beaver kinship with the patterns of landscape. Meet the Inspector General and Buttercup. Emotionally enriched, never maudlin, *Lily Pond* collects sediment and warmth. —PW

water trickles through the wooded tract, thus drowning a certain number of trees....Even in this moribund state, the trees' rotting cores serve another succession of animals, whose turn it is to thrive. Woodpeckers, owls, kingbirds, and flying squirrels find nesting sites in their decaying trunks. Nut-hatches, chickadees, and brown creepers feed on the insect life that proliferates in the rotting wood. Great blue herons construct huge nests on the forked tops of these forest relics....And at the base of these huge nests, crayfish and other aquatic creatures breed in the rising water, providing the herons plenty of food for their chicks.

But this phase also passes. When the rotting trunks of the drowned trees become so weakened by decay that they topple into the water, stored nitrogen is released and settles on the pond bottom, enriching it for that future day when the site will once again explode with meadow plants.

## Busy Activists

### Beaver: Water Resources and Riparian Habitat Manager

Rich Olson and Wayne Hubert. 1994; free. Write to Rich Olson, Department of Renewable Resources, University of Wyoming, PO Box 3354, Laramie, WY 82071-3354, 307/766-6198, rolson@uwyo.edu.

Best tempered, scientific approach. Thoughtful advice to ranchers and farmers on the benefits of accommodating beavers. The richest text to chew on, after aspen.

### Wildlife 2000

PO Box 6428, Denver, CO 80206, 303/935-4995.

A former hairdresser with contagious energy and passion, Sherrie Tippie was watching the news about some menacing beavers on a golf course. She volunteered to move them when no one else would. That was back in 1985. The self-named "beaver believer" has since live-trapped and moved 350 beaver and now gives lectures all over on this keystone species.

### Beavers: Wetlands and Wildlife

146 Van Dyke Road, Dolgeville, NY 13329, 518/568-2077, beavers@telenet.net, www.telenet.net/~beavers.

A nonprofit educational organization specializing in finding peaceful solutions for conflicts between beavers and humans. Beaver bafflers, humane traps, dam pipes, methods of fencing, and good advice are part of their toolkit.

### Beaver Stop

DCP Consulting Ltd., 3219 Coleman Rd. NW, Calgary, Alberta T2L 1G6 Canada, 800/565-1152 or 403/282-2506, fax 403/220-9591, www.nucleus.com/~beavstop/.

Prevents beavers from damming the entrance to and the interiors of culverts. Little or no resistance to water flow.

### Live Beaver Trap

Hancock Trap Company, Box 268, Custer, SD 57730, 605/673-4128.

The safe and humane way to trap and relocate unwanted beavers.

### Bioregional Beaver Passion

#### Keystone Project

Grant County Conservationists, HCR 77 Box 2070, John Day, OR 97845, 541/575-0673.

All over Oregon, Keystone creates watershed restoration coalitions using beavers as a management tool.

#### The Beaver Defenders

Unexpected Wildlife Refuge, Inc., Box 765, Newfield, NJ 08344, 609/697-3541.

New Jersey's beaver advocates won a ban on leghold traps. They maintain a 500-acre refuge.

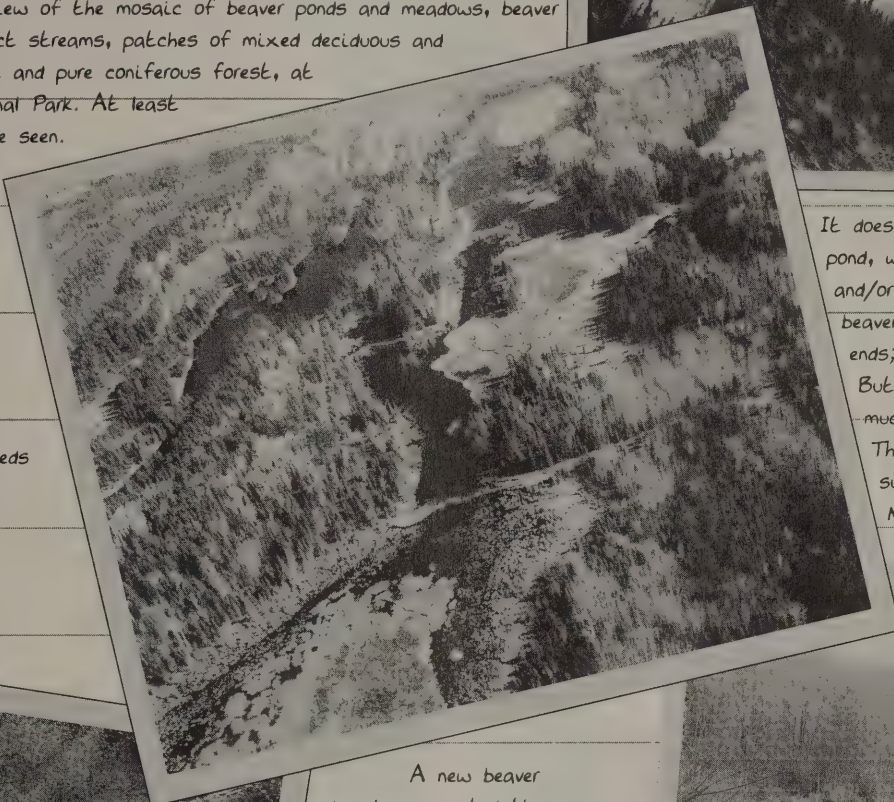
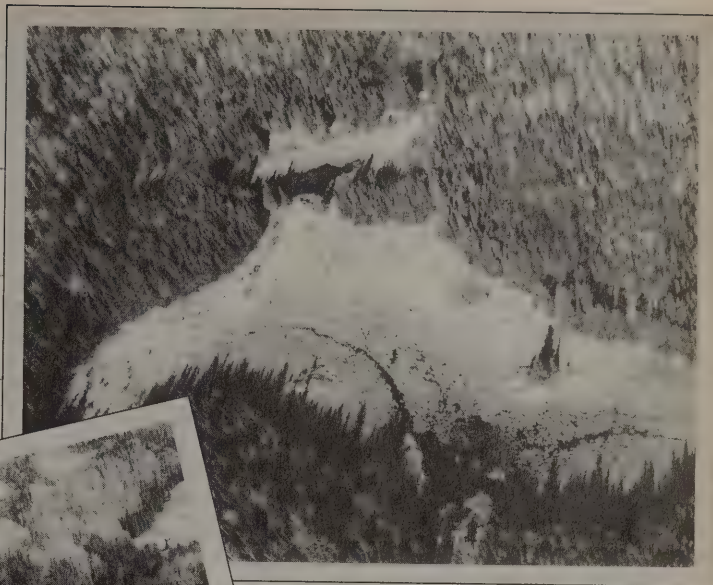


# Waterworks

A watershed's drainage net, and the specific channel's structure (width, depth, gradient, erodibility) are the natural framework or ecostructure for the beaver population's endeavors. The beaver-modified watershed buffers the peaks-and-lows in streamflows. As seen in the photo, flat floodplains that allow construction of shallow canals leading to food sources are ideal.

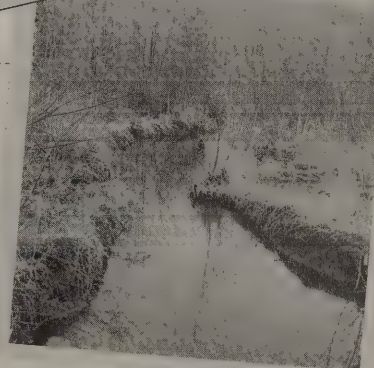
An aerial view of the mosaic of beaver ponds and meadows, beaver canals, and intact streams, patches of mixed deciduous and coniferous forest and pure coniferous forest, at Voyageurs National Park. At least five dams can be seen.

The pure stands of conifers are largely the result of selective cutting by the beaver. Beaver populations can modify the ecostructure of watersheds hundreds of square miles in area.



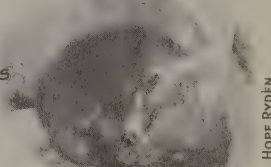
A new beaver dam has promoted the invasion of the streambed by shrubs, and created a hard edge contrast between water and land. The beaver at VNP flooded first those areas that would make the largest possible ponds with the greatest potential for expansion.

HOPE RYDEN



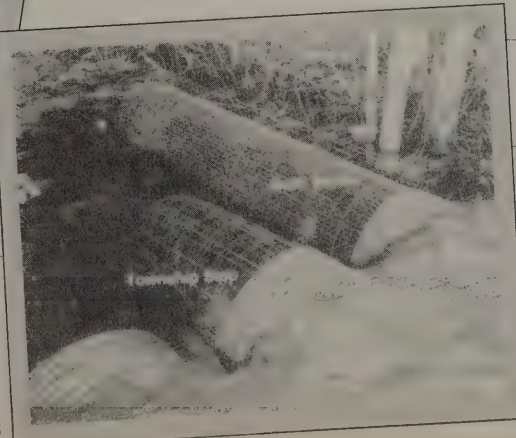
Beaver-dredged canals are labor savers, used to float harvested trees to the ponds and dams.

The beaver baffle is a simple device consisting of a long mesh tube three layers thick. When properly fitted into the culvert, water spurts through in so many places that beavers are at a loss to stop it.



HOPE RYDEN

Beaver don't gnaw trees willy-nilly. With their heads tipped sideways, the upper incisors anchor crosswise into the trunk while the lower teeth do the chopping, chiseling, and ripping.



HOPE BUYUKMIRICI

PHOTOS TAKEN AT VOYAGEURS NATIONAL PARK, INTERNATIONAL FALLS, MINNESOTA BY CAROL A. JOHNSTON, PH.D., SENIOR RESEARCH ASSOCIATE AT THE NATURAL RESOURCES RESEARCH INSTITUTE, UNIVERSITY OF MINNESOTA.



C. S. Holling

# THE RENEWAL, GROWTH, BIRTH, AND DEATH OF ECOLOGICAL COMMUNITIES

**A promising new model questions old ideologies, brittle beliefs, and ecological ideals. Is it a guide to more mindful actions?**

**P**ERHAPS I HAVE BEEN IN THE game too long to be sympathetic to “Chicken Little” stories of catastrophe. In 1969 *Time* magazine entitled an article “The New Jeremiahs” and featured six scientists who were prophesying doom—an environmental doom that may have been novel then but that is familiar now. I remember they included Paul Ehrlich, Barry Commoner, Ken Watt, and—me! Now, twenty-five years later, I find the articles that repeat the same litany of doom to be not necessarily wrong, but tiresome, unconvincing, and weak.

What is really disturbing is that they ignore the remarkable advances, learning, and understanding that have occurred in the intervening years. They ignore the opportunities for conversations among and actions by previously polarized individuals that increase both understanding and the ability to develop and apply integrated and adaptive policies. The topics revolve around five interrelated themes—regional resource management and devel-

opment, ecosystem restoration, sustainable development, global change, and biodiversity. Population growth and technology drive them all.

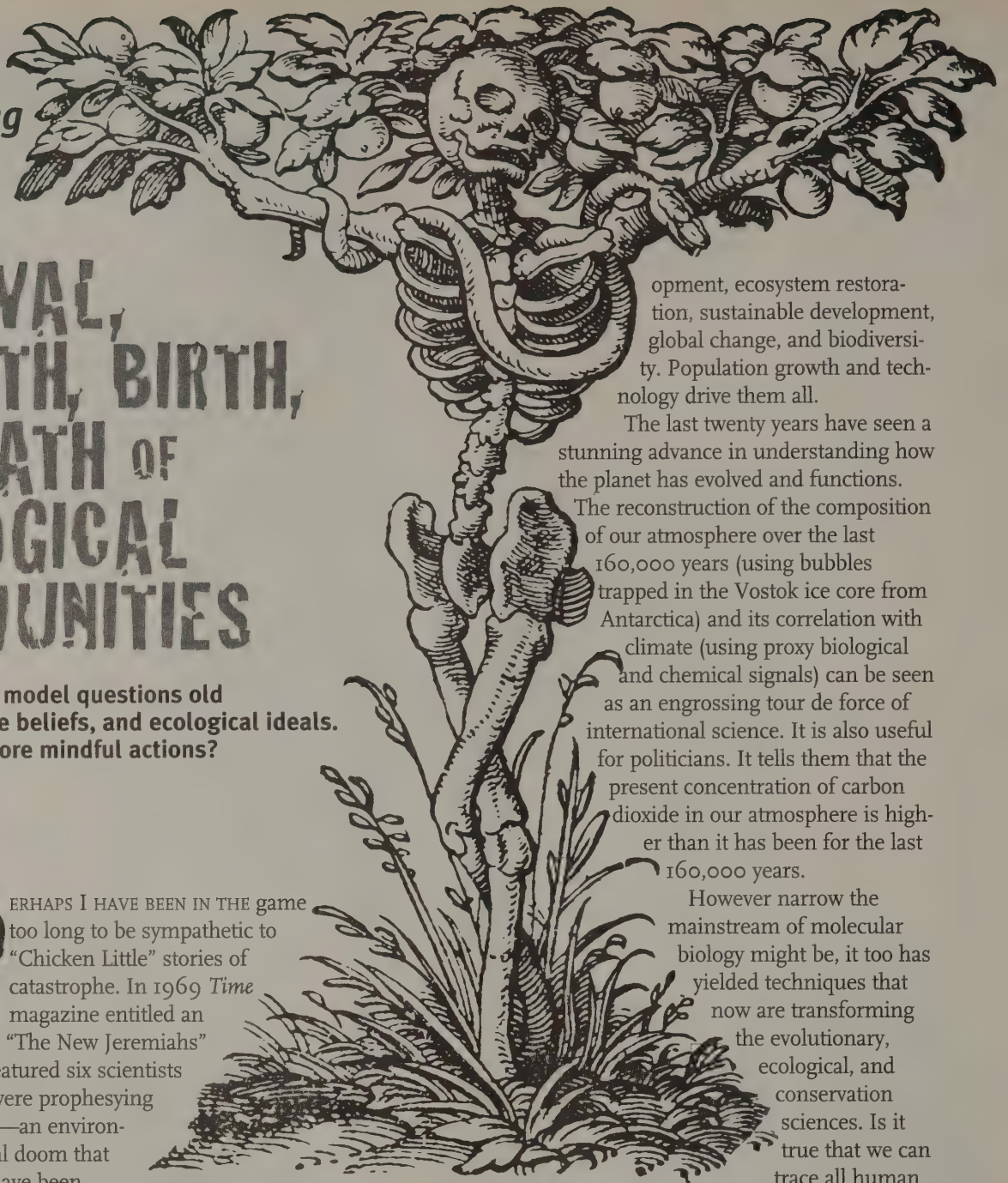
The last twenty years have seen a stunning advance in understanding how the planet has evolved and functions.

The reconstruction of the composition of our atmosphere over the last 160,000 years (using bubbles trapped in the Vostok ice core from Antarctica) and its correlation with climate (using proxy biological and chemical signals) can be seen as an engrossing tour de force of international science. It is also useful for politicians. It tells them that the present concentration of carbon dioxide in our atmosphere is higher than it has been for the last 160,000 years.

However narrow the mainstream of molecular biology might be, it too has yielded techniques that now are transforming the evolutionary, ecological, and conservation sciences. Is it true that we can trace all human

mitochondrial DNA back to an “Eve” in Africa? Biologists now can certainly unravel affinities in related groups of species and individuals and can join the geophysicists in compelling reconstructions of the past. At the least, molecular biology can help put our present problems in a perspective—from the role of past extinctions to present declines in biodiversity.

But we must recognize what this means and the challenge it presents. The relevant biophysical processes operate over an enormous scale, potentially from soil processes operating with time constants of hours or days in meter-square patches; to ecosystem successional processes of decades to centuries covering tens to thousands of square kilometers; to global biotic processes involved in the regu-





lation and isolation of elements like carbon, which have time lags of millennia and a global impact. This is why satellite imagery, remote sensing, and geographic information systems, now routinely available to analyze patterns, are of such major consequence. Computer advances have made it possible to visualize complexity in both space and time. It is a picture of discontinuous behavior, of multiple stable states, of the interaction between slow forces that accumulate environmental capital and fast processes that slowly exploit, suddenly release, and renew the capital. It is as far a cry from public perceptions of fragile, stable, and equilibrium nature as could be imagined (see box: "Five Paradigms of Nature"). And that knowledge too is useful. It is the foundation for the regional experiments in adaptive policy design and management that are as much examples of institutional learning as they are of using science for public policy.

### On Theory

"Don't give me academic theory; give me practical advice and actions!" That's what I heard, appropriately, in the certainty of the 1970s. But at a time of confusion, such as the 1990s, promising and relevant theory is the only antidote to dated ideology or belief. And the intriguing paradoxes that have emerged—by applying past incomplete theories of equilibrium, of gradual change, and of control—have set a foundation for new theories of discontinuous change and evolution. Oddly, one of the most practical things we could recommend now is massive support for the expansion of new theory.

The intensity and global nature of the changes now taking place are moving the planet and its occupants into totally new behavior. In this transformation some consequences can be predicted, others will

be uncertain, and still others will be unpredictable. It is essential to be guided by theories of change that can contain short- and long-term changes, gradual and abrupt ones, and dynamic and structural ones. The theories will determine the questions we ask, the problems we perceive, the data we collect and analyze, and the policies and actions we initiate. Theories that do not match the problem can be at best delusions and at worst dangerous.

The discovery of the hole in the ozone layer is an example. It was not detected initially by satellite imagery, because the smoothing algorithm applied to the data *assumed* that abrupt changes could only be caused by instrument glitches. The implicit theory presumed gradual, continuous change in atmospheric chemistry and chemical composition.

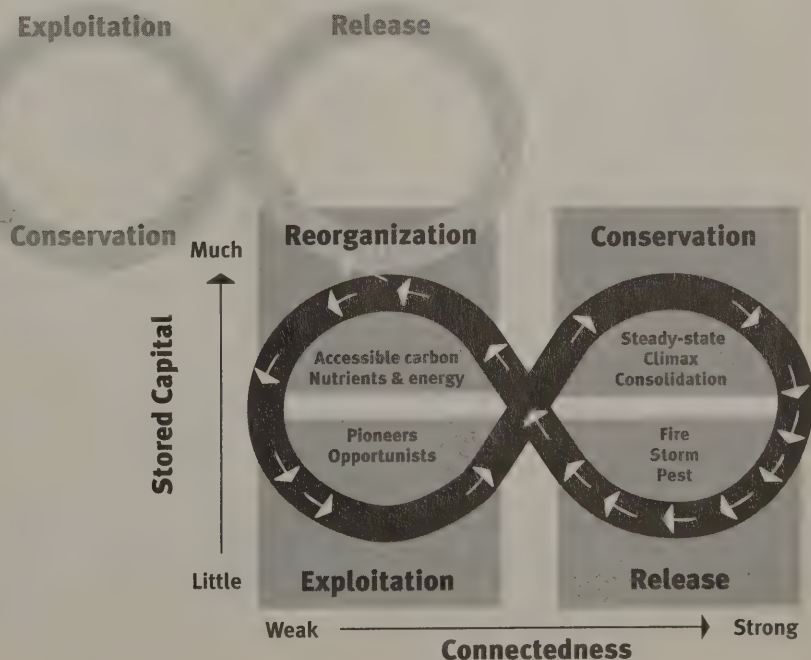
There are also many examples of theories that have had more disastrous consequences. One recent example is the devastating events in the Sahel of Africa. External changes in precipitation were partially responsible for the collapse, but such changes have occurred and been absorbed before. The response was exaggerated by increased vulnerability of a culture and ecosystem caused, in part, by development aid that broke the patterns of nomadic movement and social adaptations that had evolved in these semi-arid savannas. No adequate theory was utilized to relate the resilience of local ecosystems and the adaptive flexibility of people to drought and the migrations of people and animals.

Regional changes such as the Sahel's and the anticipated global ones make the world we are entering one of surprises, with consequences that threaten to overwhelm the adaptive capacities of individuals, business, and government. Investing in the development and testing of usable and useful theory is therefore not an academic luxury, but a

The four ecosystem phases and the flow of events between them. According to this model, an ecological community passes through: the Conservation Phase, with its great connectedness, energy stored in biomass, and low leakage of nutrients; the Release Phase, when some dramatic event disturbs the consolidated biomass, foodweb, and nutrient cycles; the Reorganization Phase, which is the most formless, with free-floating nutrients, less trapped energy, and many open niches; and the Exploitation Phase in which species that can exploit these opportunities invade or increase and, over time, lock in new foodwebs and nutrient cycles.

The arrows show the speed of the flows in the ecosystem cycle. Where arrows are close to each other, changes are rapid. Arrows far from each other indicate a slowly changing situation.

The cycle reflects changes in two attributes. The vertical axis shows the amount of accumulated natural capital (nutrients, carbon) stored in the dominant keystone biological organisms, litter, and soils at the moment. The horizontal axis shows the degree of connectedness among ecosystem parts. The exit from the cycle indicated at the upper left suggests the stage where a flip is most likely into a less or more productive and organized system (i.e., devolution or evolution as revolution!).





practical necessity, particularly at times of such profound change.

### The New Four-Phase Model

The traditional view of ecosystem succession has been seen as: *exploitation*, in which rapid colonization of recently disturbed areas is emphasized, and *conservation*, in which slow accumulation and storage of energy and materials are emphasized. An economist might use such labels as *market* and *innovation* for the exploitation phase and *monopolist* or *hierarchy* for the conservation phase.

But revisions in understanding indicate that two additional functions are needed. The first can be called *release*, or *creative destruction*, a term borrowed from the economist Schumpeter, in which the tightly bound accumulation of biomass and nutrients becomes increasingly fragile (overconnected, in systems terms) until it is suddenly released by agents such as forest fires, insect pests, or intense pulses of grazing. The second is one of *reorganization*, in which soil processes of mobilization and immobilization minimize nutrient loss and reorganize nutrients to become available for the next phase of exploitation. An economist might use such labels as *invention* and *reinvestment* for this stage.

During this four-phase “infinity sign” cycle (see figure on previous page), biological time flows unevenly: from the exploitation phase, slowly to conservation, very rapidly to release, rapidly to reorganization, and rapidly back to exploitation. During the slow sequence from exploitation to conservation, connectedness and stability increase and a “capital” of nutrients and biomass is slowly accumulated. That capital becomes more and more tightly bound, preventing other competitors from utilizing the accumulated capital until the system eventually becomes so overconnected that rapid change is triggered. The agents of disturbance might be wind, fire, disease, insect outbreak, or a combination of these. The stored capital is suddenly released and the tight organization is lost to allow the released capital to be reorganized to initiate the cycle again.

This pattern, though drawn as continuous loops, is actually discontinuous. It depends on changing multistable states to trigger and to organize the release and reorganization functions. Instabilities and chaotic behavior trigger the release phase, which then proceeds in the reorganization phase, where stability begins to be reestablished. In short, chaos emerges from order, and order emerges from chaos! Resilience and recovery are determined by the fast release (or creative destruc-

## Five Paradigms of Nature



**W**e are only now beginning to understand the changing reality. There is no limit to the ability of a good scientist to invent compelling lines of causal explanation that inexorably support his or her particular beliefs. How can even the best-intentioned politician possibly be expected to deal with that? How can even the most reflective citizen? With every issue having supporting evidence and contradictory counterevidence (all legitimate), the issues seem to involve no independent reality of nature, only moral issues that can be debated. Can we ever separate belief from fact?

**Nature Cornucopian** is one of smooth exponential growth where resources are never scarce because human ingenuity always invents substitutes. It was the basic view of Herman Kahn and the foundation for Julian Simon's arguments. It assumes that humans have an infinite capacity to innovate and that nature changes gradually—fast enough to be detected yet slow enough to be managed.

**Nature Anarchic** is hyperbolic, where increase is inevitably followed by decrease. It is a view of fundamental instability, where persistence is only possible in a decentralized system in



which there are minimal demands on nature. It is the view of Schumacher and some extreme environmentalists. If the previous view assumes that infinitely ingenious humans do not need to learn anything different, this view assumes that humans are incapable of learning how to deal with the technology they unleash.

**Nature Balanced** is one of logistic growth, where the issue is how to navigate a looming and turbulent transition—demographic, economic, social, and environmental—to a sustained plateau. This is the view of several institutions with a mandate for reforming global resource and environmental policy—the Bruntland Commission, the World Resources Institute, the International Institute of Applied Systems Analysis, and the International Institute for Sustainable Development, for example. Many individuals are contributing skillful scholarship and policy innovation. They are among some of the most effective forces for change.

**Nature Resilient** is one of nested cycles organized by fundamentally discontinuous events and processes. That is, there are periods of exponential change, of growing stasis and



brittleness, of readjustment or collapse, and of reorganization for renewal. Instabilities organize the behaviors as much as stabilities. This was the view of Schumpeter's economics, and it has more recently been the focus of fruitful scholarship in a wide range of fields—ecological, social, economic, and technical. This has formed the body of my own ecological research for the past twenty years.

**Nature Evolving** is evolutionary and adaptive. It has been given recent impetus by the paradoxes that have emerged in successfully applying the previous, more limited views. Complex systems behavior, discontinuous change, chaos and order, self-organization, nonlinear system behavior, and adaptive evolving systems are all the present code words characterizing the more recent activities. This view is leading to integrative studies that combine insights and people from developmental biology and genetics, evolutionary biology, physics, economics, ecology, and computer science. The Santa Fe Institute is an interesting experiment.





tion) and reorganization sequence, whereas stability and productivity are determined by the slow exploitation and conservation sequence.

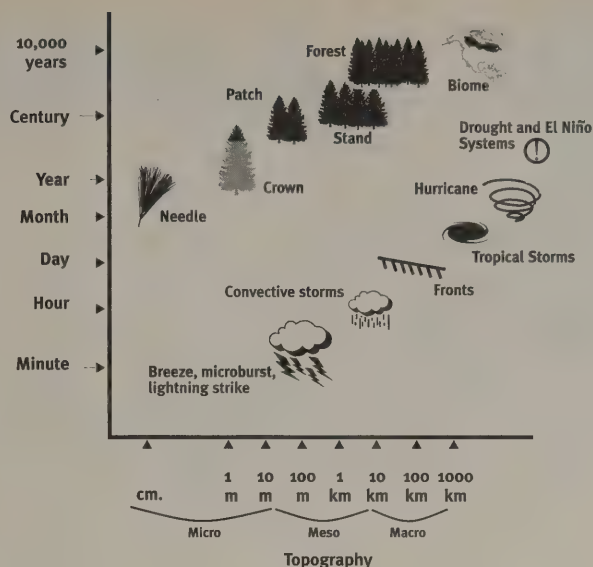
Moreover, there is a nested set of such cycles, each with its own range of scales (see figure). In the typical boreal forest, for example, fresh needles cycle yearly; the crown of foliage cycles with a decadal period; and trees, gaps, and stands cycle at a period of about a century or more. The result is a hierarchy in which each level has its own distinct spatial and temporal attributes.

A critical feature of such hierarchies is the asymmetric interactions between levels. In particular, the larger, slower levels maintain constraints within which faster levels operate. In that sense, therefore, slower levels control faster ones. If that is the only asymmetry, however, it would be impossible for organisms to exert control over slower environmental variables. This is the criticism that many geologists make of the Gaia theory: How could slow geomorphic processes possibly be affected by fast biological ones? However, it is not broadly recognized that the birth, growth, death, and renewal cycle transforms hierarchies from fixed static structures to dynamic entities whose levels are vulnerable to small disturbances at certain critical times in the cycle. That represents a transient but important bottom-up asymmetry.

There are two key phases in which slower and larger ecosystems components become briefly vulnerable to dramatic transformation because of small events and fast processes. One occurs as the system slowly moves toward maturity, when it becomes overconnected and brittle. There are tight competitive relations among the plant species. The system is highly stable (i.e., fast return times in the face of small disturbances), but from a resilience perspective, the domain over which stabilizing forces can operate becomes increasingly small. Vulnerability comes from such loss of resilience. The system becomes an accident waiting to happen.

In the boreal forest, for example, the accident might be a contagious fire that becomes increasingly likely as the amount, extent, and flammability of fuel accumulate. Or it could be a spreading insect outbreak triggered as increasing amounts of foliage both increase food and habitat for defoliating insects and decrease the efficiency of search by their vertebrate predators. It is also the phase where, in human organizations, the rebellion of aggressive interest groups can precipitate an inexorable demand for change.

During the reorganization phase, small and fast variables can also dominate slow and large ones.

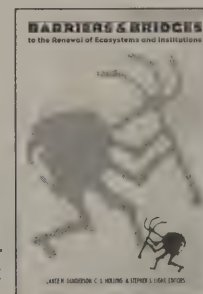


A space/time hierarchy. Top is boreal forest. Below depicts climate and weather events.

The system is underconnected, with weak organization and weak regulation. As a consequence, it is the phase most affected by probabilistic events that allow a diversity of entrained species, as well as exotic invaders, to become established. On the one hand, it is the phase most vulnerable to erosion and to the loss of accumulated capital. On the other hand, it is the stage from which jumps to unexpectedly different and possibly more productive systems are possible. Instability comes from a loss of regulation, rather than from the brittleness of reduced resilience. It is the phase in a system—ecological or human—where the individual or small groups of individuals can make the greatest structural change for the future.

This new view of alternative phases in a cycle of birth, growth, death, and renewal seems to underlie any complex adaptive system—ecological certainly; maybe human, institutional, and societal as well. The four-phase system, and viewing Nature and human institutions on multiple scales of time and space, are two of my proposed foundations for new theory. Does such a view have generality? Does it suggest what to do, and equally important, what not to do? If so, then a possible foundation exists to turn sustainable development from an oxymoron into a plan of action. ⊕

For twenty-five years, C.S. Holling has been a pioneer in ecological models and integrating them with models on human institutions, learning, and social change. He is a professor at the University of Florida. Two biospherians rushed to study with him after Biosphere 2 let them out. He indelibly expanded my own ecological perceptions with his essays on "ecosystem resilience" and "resistance," and with these excerpts from "What Barriers? What Bridges?" It is an essay in the book, *Barriers & Bridges to the Renewal of Ecosystems and Institutions*, a collection of the best hands-on studies of regional sustainability, edited by Lance Gunderson, C.S. Holling, and Stephen Light. Copyright © 1995 Columbia University Press, \$55. Used by arrangement with Columbia University Press.





## Heavy Equipment and Hotshot Operators for

# Watershed Restoration

“Nothing in nature mimics a road,” say the erosion pros at Pacific Watershed Associates. They cut their teeth on the rehabilitation of 36,000 acres of cutover land that was added to Redwood National Park in 1978 (WER 66, pp. 49-51). Novices became healers

### SETH ZUCKERMAN

as they learned to guide waterflow from roadbeds back to their original streambeds; to rehabilitate and reconstruct flood-plain terraces; to move errant boulders and logs into locations that better serve the fish; to protect banks from collapsing, unstable road cuts from caving, and to armor gullies. Whatever you're doing, decommissioning the road or storm-proofing it, there's no substitute for heavy equipment.

Geologist Terry Spreiter of Redwood National Park is fond of saying that it takes the same size equipment to repair the damage as it took to mess things up in the first place. And because the cost of renting and operating a machine goes up much slower than its size, it's usually cheapest to use the biggest equipment that will fit on site without having to widen the road to bring it in. (This reasoning doesn't apply to off-road work, where smaller equipment's daintier footprint gives it an advantage and come-alongs and chainsaw winches are more appropriate tools.) But above all, the secret is to have a good operator. “One hung-over Cat skinner on Monday morning can do an incredible amount of damage,” says Jack Monschke, a forester and watershed worker in northern California.



**Look for a 'dozer with a six-way blade, to give operators the maximum freedom to control the direction they push the dirt. The old four-way blades could go up and down, and make one side higher or lower than the other. A six-way blade has hydraulics to adjust whether one side of the blade is forward and the other back—which on the less sophisticated models means interrupting the flow of work to pivot the blade around a solid point like a stump or rock outcrop. For most road work, a Caterpillar D-6 or -7 or equivalent will suffice, though big roads and long pushes do best with a D-8. Remember to consider access for the truck bringing in the equipment, and the weight limits of any bridges you have to cross. If the dirt will have to be pushed a long distance, a U-blade beats the straight variety, since it keeps the dirt corralled better while it's being 'dozed away. A ripper on the back is a great accessory for breaking up the road surface and preparing the spot for a rolling dip, but it takes the place that a winch would occupy—so if you choose the ripper, make sure you don't need to pull yourself out of a hole.**

In California, a D-6 or comparable 'dozer will cost about \$100 an hour with operator, or some \$5000 a month to lease.

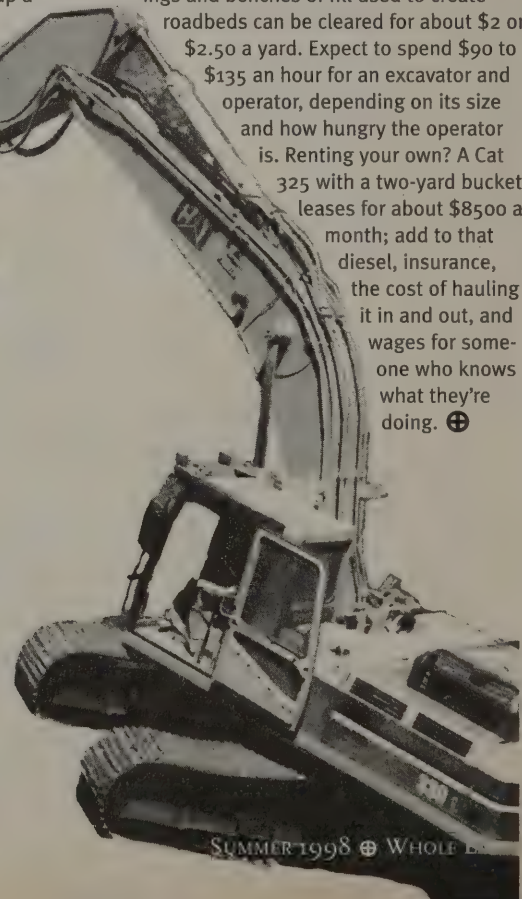
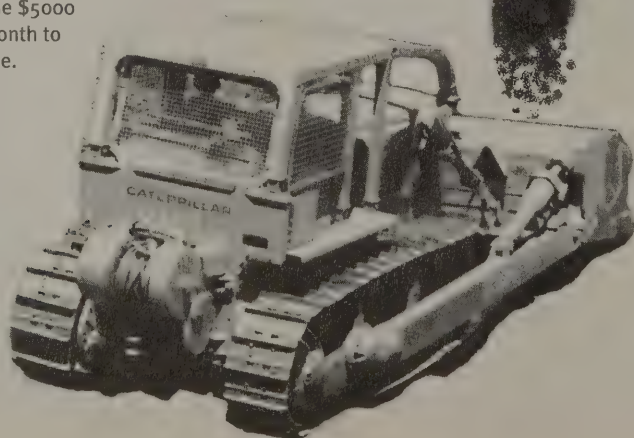


**The excavator can reach far over the bank to pull fill up onto the roadbed, where a bulldozer can then push it to a stable spot. What makes an excavator better than a backhoe is that it can swivel through 360 degrees, enabling the operator to put the fill just where it needs to go. Most restoration planners specify one with a “thumb,” which makes as big a difference for heavy equipment as it does for primates: more control in grabbing decaying logs buried in the roadbed, or placing boulders for an in-stream structure. A thumb allows the operator to pick up a log almost anywhere along its length (not just in the middle), and reduces the chance it will swing around and smash**

into the cab; the only down side is that its weight reduces the amount of dirt the excavator can move with each scoop.

The pros recommend an excavator with at least a one-and-a-half-cubic-yard bucket. The newer ones are self-leveling, meaning that the cab stays horizontal even when the tracks are at a crazy angle. The only downside is that you need more experience to tell when you're about to tip over your thirty-ton piece of equipment.

In California, streambeds can be exhumed from the roads that have been piled on top of them for about \$3 per cubic yard, and landings and benches of fill used to create roadbeds can be cleared for about \$2 or \$2.50 a yard. Expect to spend \$90 to \$135 an hour for an excavator and operator, depending on its size and how hungry the operator is. Renting your own? A Cat 325 with a two-yard bucket leases for about \$8500 a month; add to that diesel, insurance, the cost of hauling it in and out, and wages for someone who knows what they're doing. ⊕



Thanks to Jay Francke of Twin Parks, Danny Hagens of Pacific Watershed Associates, and Jack Monschke for the benefit of their experience.



## Applied River Morphology

Dave Rosgen. 1996; 390 pp. \$89.95 (\$94.95 postpaid).

## The Reference Reach Book

Luna P. Leopold, Hilton L. Silvery, and David L. Rosgen. 1998; \$19.95 (\$23.95 postpaid).

## Field Guide to Stream Classification

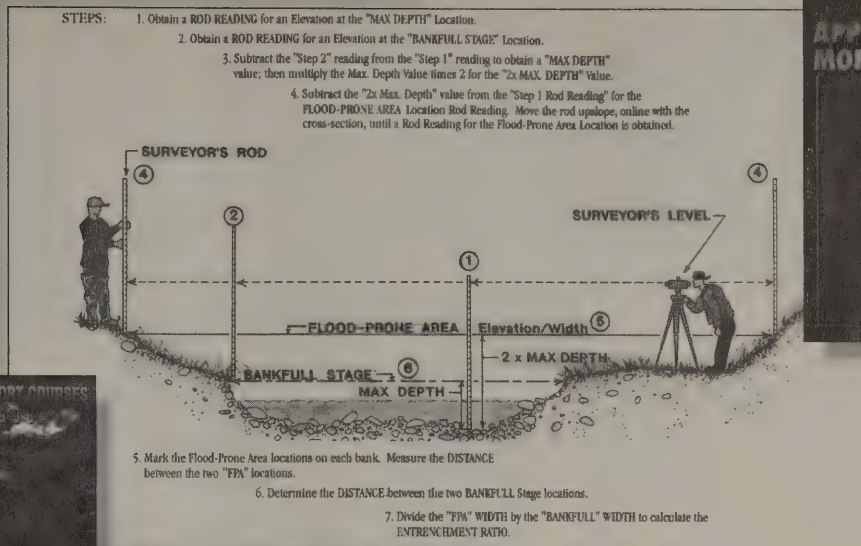
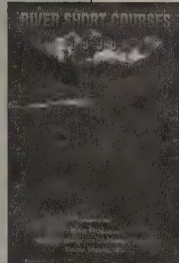
1998; 180 pp. \$45 (\$50 postpaid).

## River Short Courses Catalog

All from Wildland Hydrology Books, 157649 US Hwy 160, Pagosa Springs, CO 81147, 970/264-7100, fax 970/264-7121.

The "ecostructures" of watersheds are as unique as fingerprints. The scoopshapes of channels, their sinuosity, the texture of stream bank and bed, and the gradient of individual reaches all showcase unique hydro-personalities. The job of watershed doctors is how to return a dysfunctional dynamic water body to an aesthetic river channel that operates by itself to restore itself to the natural tendencies of its hydraulic "frame." Wildland Hydrology Consultants, owned by Dave Rosgen, offers a cluster of books, guides, and field courses that provide the latest ideas, tools, and practices to reconstruct, rehabilitate, and restore. Dave is a student of my watershed guru, Luna Leopold. Luna's aqua-autobiography, *A View of the River* (Harvard University Press) nourishes all the work of Wildland Hydrology.

Though exceptionally well illustrated, **Applied River Morphology** is not for the coffee table. It is for those struggling: what to do on a specific reach of creek or river? This text offers perspective, details, and enough quantification to prevent the cure from becoming the disease. Contents include the best river classification I know (favoring the West) and the best advice for



channel restoration. (The book does not address hill-slope stabilization or coordination between all tributaries in a single basin).

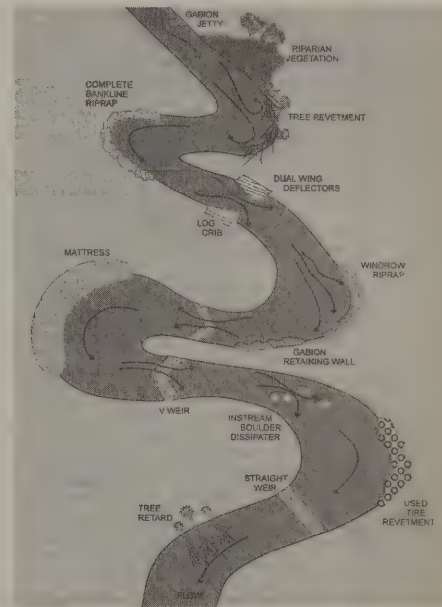
The creek and river types have been condensed from the textbook into the easy-to-carry 6" X 9" **Field Guide**. The technical data and survey forms have been condensed into **The Reference Reach Book**. In addition, Dave sponsors a summer school near Pagosa Springs, Colorado for professionals, students, and other maniacal watershed lovers who want hands-on experience, unique expertise, and competence in applying his "tool kit" for watershed doctoring. Besides applied fluvial geomorphology, recent courses include water rights and instream flows, and grazing in riparian ecosystems. From my perspective, Wildland Hydrology surpasses any university in providing real-life, "post-graduate" watershed learning. If civil engineering is to change, its cradle may be in Pagosa. Being private, all items and courses are Ivy League expensive. —PW

“What is the probable stable form of the stream type under the present hydrology and sediment regime?”

...Many restoration projects have the right dimensions for the channel, but the pattern (meander geometry) is not matched to this pattern....

The design and placement of proper pool/riffle and/or step/pool sequences as a function of the stream width and gradient is critical for natural stability....On the average, the meander wavelength is 10-14 bankfull widths, then the spacing between pools is 5-7 bankfull widths....It has been difficult in

the past to develop the proper "natural channel" design width. The stream classification system, however, can assist in the calculation by establishing the stable (from reference reaches) width/depth ratio for the selected stream type...[For instance], the purpose of Wildcat Creek restoration was to secure "natural stability," for both physical and biological function, restore fish migration, and improve aesthetic values. Wildcat Creek experienced a near record 100-year flood in January 1995 and maintained its "natural stability" with minimal post-flood maintenance, effecting less than 5% of the restored channel.



Stream "improvement" options. —APPLIED RIVER MORPHOLOGY

Far left: meander widths. Average value is the total width of the curve divided by the width of the stream. —APPLIED RIVER MORPHOLOGY

STREAM TYPE	A	D	B & G	F	C	E
PLAN VIEW						
CROSS SECTION VIEW						
AVERAGE VALUES	1.5	1.1	3.7	5.3	11.4	24.2
RANGE	1 - 3	1 - 2	2 - 8	2 - 10	4 - 20	20 - 40



## How water hyacinths govern WATER QUALITY



Right:  
Bacterial sex  
happens: conju-  
gation.

**W**hat does it mean when we say a biological organism “governs” a flow of energy and materials? The beautiful and pesky water hyacinths (fastest growing large plant on the planet) support bacterial colonies that cooperatively purify water. Because the water hyacinths (not really a hyacinth) have been watched more than other plants, their governing parts are better known. Water hyacinths treat wastewater in many cities in the United States (San Diego, Tucson, Austin). Other plants, microbial colonies, and animals mixed with water hyacinths improve resilience and redundancy and extend the season of maximum effective treatment. Ocean Arks builds Eco-Rafts that float in acidified lakes to help improve water quality, and their Living Machines use a wide variety of species.

### LEAVES AND AERIAL PARTS

**Algae control:** The canopy of leaves shades the water and prevents the growth of algae. Since algae contribute to dirty water (what engineers call “total suspended solids”), the leaf canopy helps clarify the flow.

**Temperature regulator:** The canopy of leaves insulates the water, maintaining warmer temperatures which are better for the bacteria that will perform much of the purification (below).

**Turbulence reducer:** The whole plant buffers the wind, reducing turbulence. The quieter waters make it easier

for suspended solids to settle and the water is clearer.

**Carbon source:** The green leaves transform sunlight into a soluble of carbon that leaks through the roots and feeds the purifying bacterial colonies. Sunlight replaces petroleum fuels as the energy and food source to power wastewater treatment.

**Self-maintenance:** By dying back and regenerating, the water hyacinths adjust leaves, roots and petiole to do maximum work for the season.

### ROOTS

**Aerator:** During photosynthesis, the leaves send oxygen to the roots which feed the attached bacterial colonies. This system substitutes for mechanical aerators.

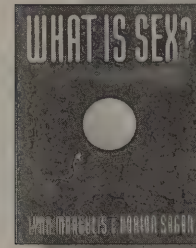
**Biological filter:** The fibrous and feathery roots filter suspended solids from the water flow. They provide the surface media for bacteria to biochemically renovate carbonaceous and nitrogenous wastes. The roots adjust their size to the concentration of nutrient.

**Clarifier:** Slows down flow in root/petiole allowing settleables to sink. The slower flows allow bacterial colonies to grow on roots.

**Plant uptake:** During the growing season, water hyacinths absorb some phosphorus and nitrogen, some heavy metals and refractory organics. The rootlets and biofilms hold many contaminants, including viruses, to the root surface.

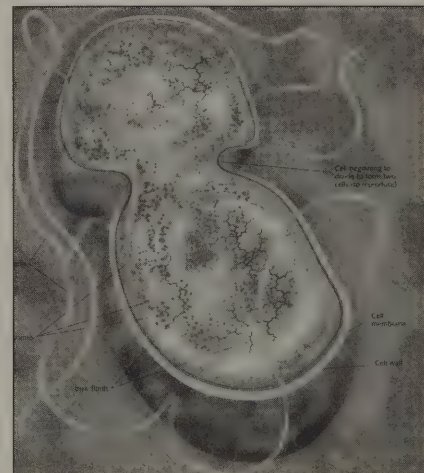
## What is Sex?

Lynn Margulis and Dorian Sagan. 1997; 256 pp. \$37.50. Simon & Schuster.



The Margulis/Sagan team has done it again. The most interesting text written on sex, especially the early evolution of “sex” among bacteria and the origin of what we more classically call sex and cellular involvement with sex. Suffused with suggestive language to keep the

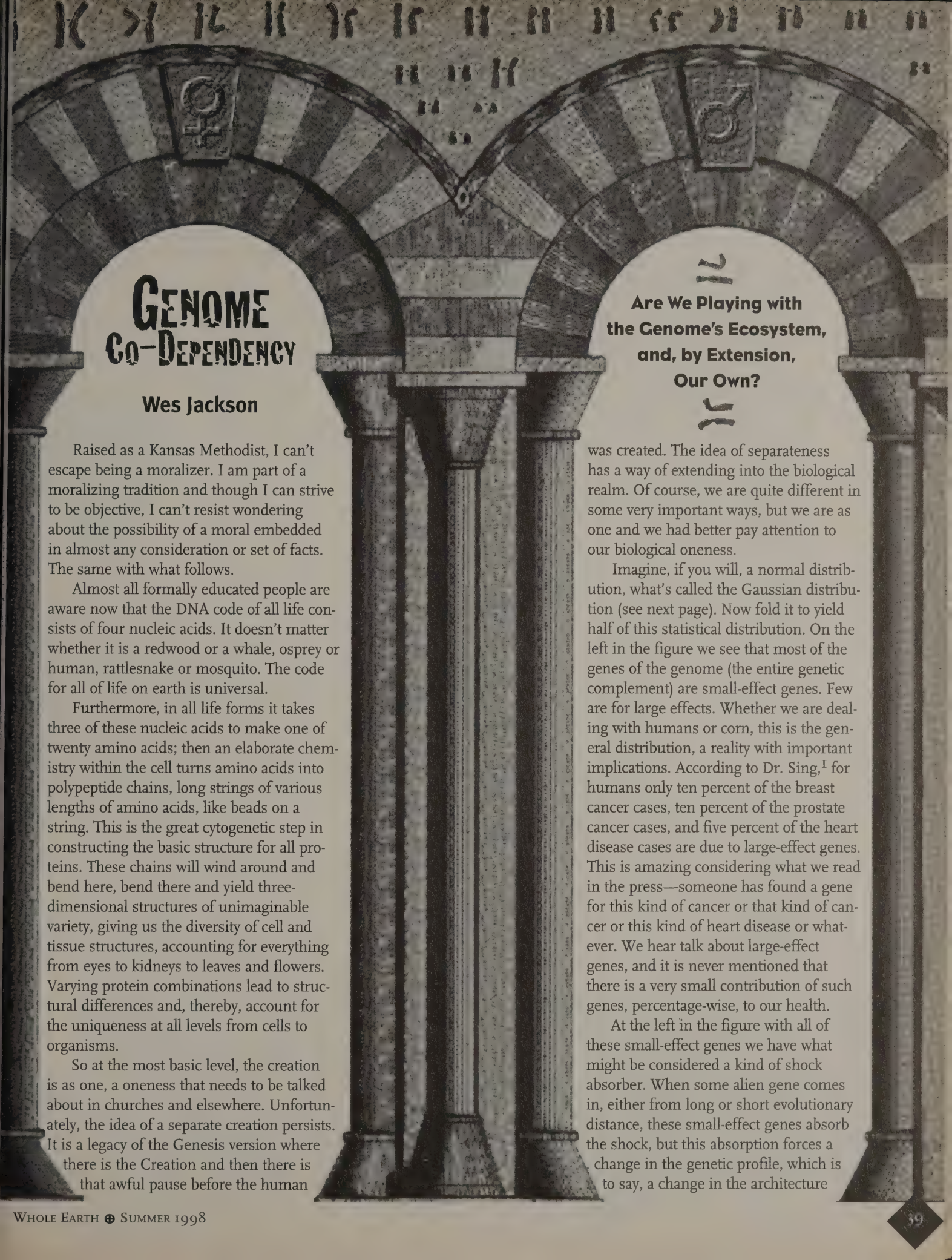
prose hot. What if humans had bacterial powers and you swam with your dog? **What is Sex?** emerges as the only book around to deal with the sexual attraction and mating as the governor of much behavior from the bacterial realm (and even bacteria indulge in trans-species gene donations) as well as futuristic cybersex (manipulation of the hormonal, genetic, technological, neuronal underpinnings of our romantic love). Beautifully illustrated, though the gorilla shown (p. 189) is not angry, as the caption claims, and the Celebes ape (p. 182) is not a mandrill. —PW



“ To the public sex means naked men and women coupling; to the physicians sex is the cause of AIDS; to the moralist, constrained by rigid dichotomies, sex means only two alternatives: male or female. Why is sex so misunderstood? Is it because no one knows its history?”

“ Bacterial sex, the first kind of sex on this planet, is speedy sex. Gene-excreting and gene-grabbing bacteria are still able to confer new traits immediately in the parent itself rather than through the parent, to the offspring. As stressed by neo-Darwinian theory, mutations, random changes in DNA, were important. Occasionally, mutated DNA allowed bacteria to access new food sources and survive at higher temperatures. But only with sex could a single bacterium access the genetic resources of the entire planet.





## GENOME Co-DEPENDENCY

Wes Jackson

Raised as a Kansas Methodist, I can't escape being a moralizer. I am part of a moralizing tradition and though I can strive to be objective, I can't resist wondering about the possibility of a moral embedded in almost any consideration or set of facts. The same with what follows.

Almost all formally educated people are aware now that the DNA code of all life consists of four nucleic acids. It doesn't matter whether it is a redwood or a whale, osprey or human, rattlesnake or mosquito. The code for all of life on earth is universal.

Furthermore, in all life forms it takes three of these nucleic acids to make one of twenty amino acids; then an elaborate chemistry within the cell turns amino acids into polypeptide chains, long strings of various lengths of amino acids, like beads on a string. This is the great cytogenetic step in constructing the basic structure for all proteins. These chains will wind around and bend here, bend there and yield three-dimensional structures of unimaginable variety, giving us the diversity of cell and tissue structures, accounting for everything from eyes to kidneys to leaves and flowers. Varying protein combinations lead to structural differences and, thereby, account for the uniqueness at all levels from cells to organisms.

So at the most basic level, the creation is as one, a oneness that needs to be talked about in churches and elsewhere. Unfortunately, the idea of a separate creation persists. It is a legacy of the Genesis version where there is the Creation and then there is that awful pause before the human

## Are We Playing with the Genome's Ecosystem, and, by Extension, Our Own?

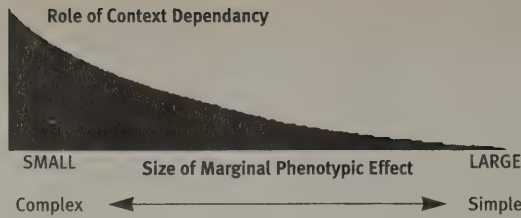
was created. The idea of separateness has a way of extending into the biological realm. Of course, we are quite different in some very important ways, but we are as one and we had better pay attention to our biological oneness.

Imagine, if you will, a normal distribution, what's called the Gaussian distribution (see next page). Now fold it to yield half of this statistical distribution. On the left in the figure we see that most of the genes of the genome (the entire genetic complement) are small-effect genes. Few are for large effects. Whether we are dealing with humans or corn, this is the general distribution, a reality with important implications. According to Dr. Sing,<sup>1</sup> for humans only ten percent of the breast cancer cases, ten percent of the prostate cancer cases, and five percent of the heart disease cases are due to large-effect genes. This is amazing considering what we read in the press—someone has found a gene for this kind of cancer or that kind of cancer or this kind of heart disease or whatever. We hear talk about large-effect genes, and it is never mentioned that there is a very small contribution of such genes, percentage-wise, to our health.

At the left in the figure with all of these small-effect genes we have what might be considered a kind of shock absorber. When some alien gene comes in, either from long or short evolutionary distance, these small-effect genes absorb the shock, but this absorption forces a change in the genetic profile, which is to say, a change in the architecture



Figure of the Folded Gaussian Distribution.



of the genome—overall an important consequence. I suspect that what we are looking at here is the very basis of bodily homeostasis. It is one of those times that we say, “Aha, this must be the way that multicellular creatures of this planet have managed to be resilient to the perturbations coming at them in a world that is fundamentally unknowable!” This is Darwinian evolution at the most basic level.

Various cathedrals are known for their wonderful arches, the structures responsible for supporting the roof. The space between the arches is called spandrel; in churches it is bricked in. The spandrel is a derivative, a place between the arches. In biological systems, that which is under genetic selection at one point may be analogous to that arch.<sup>2</sup> The spandrel, once bricked in, is likely to be plastered over and then painted with a fresco. At this point the story changes. The spandrel takes on greater significance when visitors from a town in Tuscany or Umbria arrive in Venice and say, “We want our church to be like that. We want to be able to paint a fresco on the plastered spandrel.” At this point the spandrel itself, indeed the fresco, is an object of natural selection.

This analogy helps explain how some characteristics may be only a consequence of a derivative. The spandrel as derivative of the arch and the fresco as a derivative of the spandrel can now have an adaptive value, meaning it is consciously subject to selection.

Let’s say a group from an agri-business company like Monsanto arrives with an interest in having a fresco, and being bottom-line people, they set out to find the gene for fresco-hood. Now comes the basis for a moral, for if one hunts for the gene for fresco-hood, *and only fresco-hood*, one had better be prepared to bring along many other traits because a change will be forced on the overall architecture of the cathedral.

For a couple of decades corn dramatically responded to an increase in nitrogen fertilizer. Breeders were selecting for “fertilizer-response genes.” At least this was the language of the breeder, and understandably so. But what was happening at a biological level was the *elimination* or *neutralization* of the genes responsible for the plant’s ability to discriminate in the rate of fertilizer uptake. The biological reality was assigned another name, “fertilizer-response genes.” That era of fertilizer-response flattened, but now it is climbing again. What is going on? I suspect that it is climbing because breeders are working with a different genetic

## The Ecology of the Genome

The history of hereditary features has glamorized reductionist science. In the 1850s, Anglo-Europeans believed that hereditary features came in the blending male and female fluids. Then, with microscopes, they believed it was in the sperm or/and ova. When Mendel was rediscovered around 1900, hereditary features turned from fluids to units, the units we now call genes. As microbiology and chemistry blossomed, the hereditary features were allegedly isolated in chromosomes, then genes, then the twisted ladders of DNA, then nucleotide sequences.

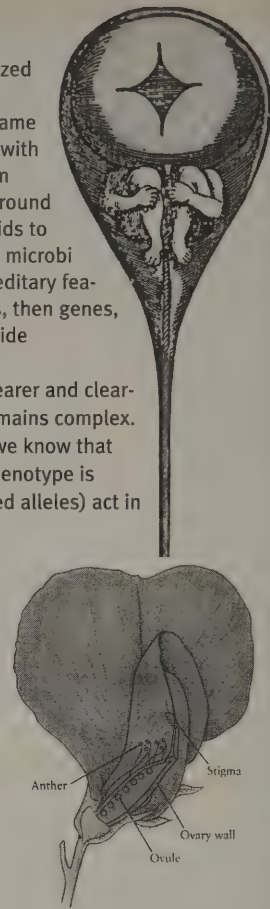
But, while hereditary structures became clearer and clearer, hereditary transmission and expression remains complex. Lucky Mendel crossbred simple peas. Today, we know that the expression of the genotype in the phenotype is complex. Genes (and their parts, called alleles) act in unpredictable ways, their expression as proteins is modified by RNA, the cell’s environment as well as the physiology of the body as a whole. DNA is not a naked blueprint. It is thickly embedded in the nucleolus, nucleus, and a wonderfully rich cytoplasmic “ecosystem” with “biostructures,” symbionts and networks of vesicles, microtubules and filaments, and mini-transformers like ribosomes and Golgi bodies.

Mendelian heredity is a special and, probably, very rare instance of simple genotype-phenotype expression. More often, “gene” expression and “gene” regulatory powers show up incompletely (e.g., co-dominance). Genes can hide each other’s expression, mix up many alleles, show variable expression or, as they say, “reduced penetrance.” The phenotype is rarely the result of one gene but of many (polygenic inheritance) leading to graded expressions. Or, a single gene, in the company of others, can express multiple traits (pleiotropy). Genes can link or sort independently or even jump.

What happens to the cell ecosystem when you add, subtract, double or move one “gene” on the chromosome in the nucleolus? How long does the cell “ecosystem” take to react and change the overall cellular landscape? This is the question posed by biotechnology.

ensemble responsible for that response. All genes interact. And as selection pressure is applied, as when humans seek an improved wheat or corn variety or improved cow or sheep, we are restructuring the genome of this miniature ecosystem. We can get away with this, for a while. We have gotten away with it for a long time now, just as we have with farm pesticides. With ordinary plant breeding, breeders get away with these modifications because they are forced to deal with phenotypes (the way traits are expressed, usually at the organism level) and unavoidably drag along the genotype (the genetic code). With gene splicing it is the other way around.

As the agricultural revolution began and advanced in various places, around the world, eight to ten thousand years ago, the genomes of our crops and livestock—miniature ecosystems really—were altered. With alteration came a degree of dependen-



Opposite: The homunculus was a short-lived theory. After the microscope, sperm was discovered and considered to be the sole origin of inheritance. Below is Mendel’s famous pea which, luckily for him, had simple hereditary characteristics.



cy on the species responsible for the alteration, *Homo sapiens*. Of course, we became dependent on them, too. Interdependence evolved as these agriculturists altered the genetic architecture of some wild species, and established, not a one-way dependency, but a two-way dependency. To be anthropomorphic for a moment, the various plants and animals were saying, "Look what we have to offer," and we effectively said, "Oh yes, we would like to have that. If you provide us with a more or less assured abundant grain supply or meat supply or cream or egg supply, we'll take care of you. With you grain producers, however, we have to make some changes. Your seeds shatter. We don't want to pick them off the ground one by one, so those among you that tend not to shatter we'll pick as parents of our future crops."

This shameful anthropomorphic version should not minimize the importance of the consequence of something so modest as the selection for shatter resistance. As wild species they were independent of us, but those first few cuts of selection for something as simple as shatter resistance must have *greatly* truncated and changed the genetic profile. Co-dependency likely arose very early in domestication. Without us the corn plant won't live, nor the wheat plant, nor nearly any other domestic crop or livestock.

The agricultural revolution as a genetic revolution heightened dependency, heightened interdependency, and domesticated us as we domesticated the crops and livestock. The nano-ecosystem<sup>3</sup> of all involved species was altered. It is a Darwinian reality.

### Spirit, Choice, and Genes

The separation of spirit and body, a biblical idea, needs to be re-examined. Gary Nabhan, an ethnobotanist and founder of Native Seed Search in Arizona, told of an encounter many years ago in Mexico. He saw an Indian woman with an array of corn ears arranged in front of her. Some were tiny little nubbins, some nice long ears, and a range in-between. There were many different colors and she

## Terminator Technology Prevents Farmers from Saving Seed

The twelve-thousand-year-old practice of the farmer and his family saving their "best" seed from one year's harvest for planting the next season is about to clash with "Terminator Gene-Technology." An American company, Delta & Pine Land Co., and the US Department of Agriculture announced that they had patented a technique that genetically disables a seed's capacity to germinate when planted from its parent. Shortly after 2000, the terminator gene will be ready for a wide variety of crops. Now, it terminates re-seeding in cotton and tobacco.

Terminator Technology will change the world of crop seed competition. If the Terminator is added to major crop varieties of wheat and rice, will it force farmers to depend on a corporate monopoly and pricing? Will corporations lobby governments to change the rules of commodity markets so that "public" seeds are less competitive with "private" Terminator seeds? Is it ethical to patent a taxpayer-sponsored Terminator seed variety? Will "alternative seed companies" find a market niche selling seeds that local farmers can personally hybridize and select for local conditions? Will "seed hackers" deconstruct the Terminator seeds to allow hybrids and viable seeds to benefit poorer farmers in the Third World? Whatever the answers, corporate co-dependency will be a major dish of your future.

was taking seeds off of each one of the ears, placing them in a pan. These grains were going to be her seed supply for the next year. Gary asked her, "Why is it that you are taking the seed from the little nubbins?" She explained that corn is a gift from the gods and that it would not be showing proper appreciation for the gift if she didn't take representatives from the full array. The total interpenetration between part and whole was at work preserving the biodiversity of the germplasm. The ecologist Howard T. Odum would likely explain that "religion is the encoded language of behavior which helps to facilitate the transfer of energy through the system."

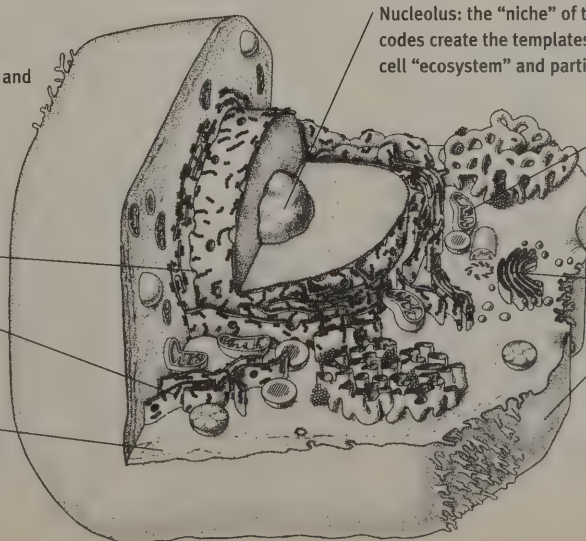
When Monsanto splices in genes from a long evolutionary distance, such as genes from bacteria into corn, it is done at a speed for which there is no precedent in the long tradition of plant and animal

### Animal Cell

A "jungle" of organelles, protein mazes, tubes, walls, symbionts, power plants, manufacturing and distribution centers.

Ribosomes: a suite of "creatures" responsible for protein synthesis both inside the nucleolus "niche" and the cytoplasm's "niche." One of the organelles.

Cytoskeleton: partially shown "ecostructure" of the cellular ecosystem. It directs molecular traffic (like a complex trail system) among other things.



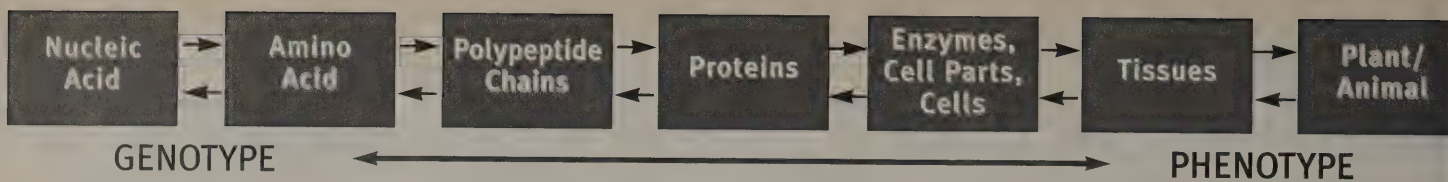
Nucleolus: the "niche" of the chromatin (chromosomes) where DNA codes create the templates for amino acids which will enter the outer cell "ecosystem" and participate in protein building.

Mitochondria: a "bacteria-like" creature that entered the cell and has become a symbiont. Responsible for providing energy for the cellular "ecosystem."

Golgi complex: packaging centers for molecules synthesized within the cell.

Cell membrane: defines the permeable boundary of the cellular "ecosystem," selectively allowing food, wastes, and information to enter and leave.





The terms genotype and phenotype hide as much as they reveal. Where does the genotype end? Where does the phenotype start? The above diagram is an oversimplified chain from DNA to the complete organism.

breeding. Traditional breeders at places like Iowa State and Pioneer Seed Company select for the phenotype (the way something looks) and are forced to drag along the genotype. Again, with gene splicing it is the other way around. Not so long ago, I talked about this problem with Dr. Don Duvick, retired former Senior Vice President and head of research at Pioneer Hi-Bred International, Inc. He mentioned that such genes brought in eventually "act like tar is being smeared on them." In other words, after a while their expression falters. Stated otherwise, the architecture of that genome is changing: the molecular background shifts. There is some kind of incompatibility at work and the new expression is disallowed by the nano-ecosystem, but this absorption has come at cost—very likely a more vulnerable, more human-dependent genome.

Is it not worth considering that the *corporation* which brings the genetic changes in the genome will create a dependency on itself or some comparable corporate entity? In other words, the scientific and technical arrangements that a corpo-

ration is capable of are not available to the run-of-the-mill breeding program. Hence, a more specialized brand of dependency on a particular kind of economic

Wes Jackson has a BA in biology, an MA in botany, and a Ph.D. in genetics. He purchased a nearly abandoned Kansas town and turned it into the Land Institute, to practice and study local standards for an agriculture that mimicks the prairies and sustains both natural and local human com-

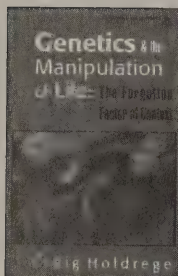
munity. If candid humor is a criteria for a Pew Scholarship or MacArthur Fellowship, it's easy to understand why Wes got both. We've reviewed just about every book he's written or edited, see *Whole Earth* No. 91 for *Becoming Native to this Place* and *Altars of Hewn Stone*.

1. My friend, Professor Charlie Sing, in the Department of Human Genetics at the Medical School of the University of Michigan, has helped me understand what follows.
2. See S.J. Gould and R. Lewontin, "The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptionist Programme," *Proceedings of the Royal Society*, 1979.

B205:581-98.

3. Editor's note: The "nano-" scale is technically  $10^{-9}$ , the scale of molecular bonding. Here Wes uses it to mean "very small," including molecular architecture ( $10^{-9}$ ) but also  $10^{-8}$  (DNA),  $10^{-7}$  (the cell nucleus and other cell components), and  $10^{-6}$  (complete cells that form tissues). These are the

bio-structures whose configurations become his nano-ecosystem. They include the "regulatory" proteins like RNA, enzymes, and others that transfer information in the development of the architecture of the cell and how the cell influences the tissue and organism scales of the phenotype.



### Genetics and the Manipulation of Life The Forgotten Factor of Context

Craig Holdrege. 1996; 190 pp.  
\$14.95 (\$19.45 postpaid).  
Lindisfarne Books, 3390  
Route 9, Hudson, NY 12534,  
518/851-9155, fax 800/925-  
1795, anthropres@aol.com.

He is great and deserves to be read! He is a high school teacher and

I think his work as a teacher underscores the lack of bias in his descriptions. He's passionately interested, in the intellectual sense, and utterly disinterested financially. **Genetics** is the single most accessible source not only of information on the implications for *Homo sapiens* of the esoterica of the new genetics and cell biology, but of knowledge and wisdom. Cutting through hype to the crux of the matter—our fundamental humanity develops in context.

—Lynn Margulis

“ In the case of the cattle:

- 2,470 cow eggs were used, of which 2,297 matured.
- 1,358 eggs were fertilized (in vitro).
- 1,154 eggs were injected with human DNA.
- 981 survived this procedure.
- 687 embryos began embryonic development (cleavage).
- 129 embryos were transferred into oviducts of cows.
- 21 cows became pregnant.
- 19 calves were born.
- 2 calves were transgenic.

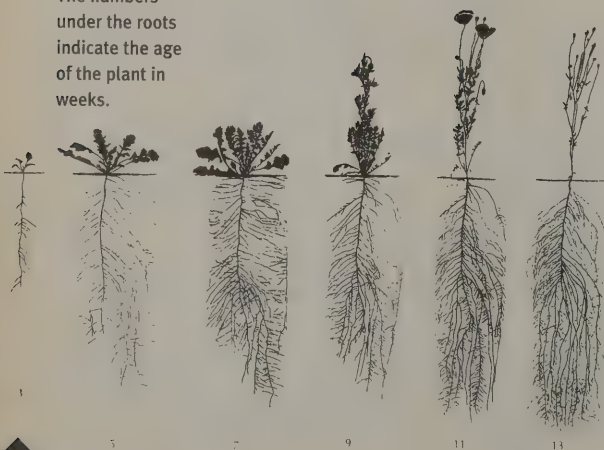
These results...show that we do not control what occurs in the organism. The surgical and analytical procedures are precise and well defined, but once the threshold between laboratory procedure and organism is breached, everything becomes opaque. The life of the organism takes over, exhibiting a certain autonomy despite all manipulation. Even if the effects of our actions penetrate into the organism, our understanding does not.

“ Every organism is continuously going beyond a mere object relation to its surroundings. What was outside is now inside—not inside as in a drawer filled with things, but, rather, inside as incorporation, as unification.

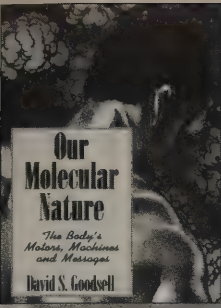
“ There are, therefore, no genes! There are—at least in the cells of higher organisms—only pieces of genes, which the cell can use when it makes proteins. A gene is by no means a molecule that exists in the cell. Rather, a gene is a task that a cell has to accomplish. Genes don't exist; they are always becoming. (Fischer, 1991, p. III; my translation).

Regardless of how one defines genes, simple, monocausal, one-directional schemes as epitomized by the Central Dogma are no longer credible. Nonetheless, the ideal of finding underlying mechanisms remains. In models, the genetic machine has become dynamic, but it remains a machine. A radical rethinking of genetic categories has not occurred. And in many minds one imperative still exists: the organism shall be reduced to its genes.

Development of a field poppy (*Papaver rhoeas*). The numbers under the roots indicate the age of the plant in weeks.







**Our Molecular Nature**  
The Body's Motors, Machines and Messages

David S. Goodsell.  
1996; 183 pp.  
\$25. Springer Verlag.

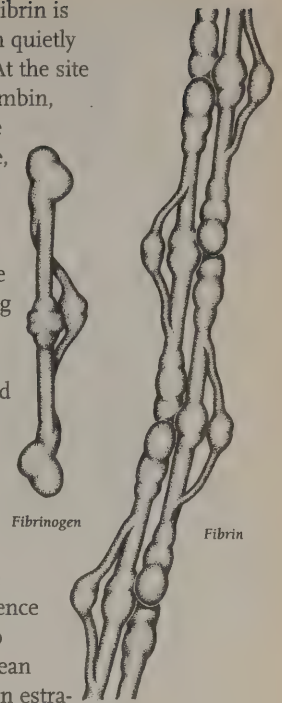
Finally, a naturalist of molecules, in the old tradition of artist/naturalist and fine crafter of prose. No longer when someone says "it's just his chemistry" will you have to nod knowingly and stupidly at the same time. Here they are: molecules for making molecules, molecules for digestion and jogging, molecules that shape your body form, venomous molecules, healing molecules, molecules of sex and the mind. In an era of AIDS and nanotechnology, small masses like molecules carry whopping impacts. A best book for a subject that has long needed a bard. —PW

“ An invisible world courses through every inch of your body. This is the world of *molecules*. Your molecules are tiny machines—millions of times smaller than machines in our familiar world—each performing one microscopic task. Each drop of your blood contains hundreds of different kinds of molecules: some transport food and air, others carry messages, others stand ready to repair an injury. In your eyes, a glittering solution of molecules refracts and focuses an image of light. A subtle change in the shape of another molecule captures this image like a sheet of film. At this moment, in your arms and hands, legions of tiny molecular motors are laboring to hold this book and to turn each page. Indeed, these words you are reading are recognized, sorted, and understood in a flurry of electrochemical impulses, organized by ranks of molecular switches.

“ The visible structure of a blood clot—the thick red glue that dries into a hard scab—is composed of blood cells

caught in a web of fibrin fibers. Fibrin is built as inactive fibrinogen, which quietly circulates throughout the blood. At the site of a wound, it is activated by thrombin, which clips off small pieces at the center. This opens up a sticky site, and the slender fibrin molecules bind side by side, assembling a tough, double-stranded cable. These cables branch and associate with neighboring strands, forming a tangled web. When the strands are in place, crosslinks lock them into a rigid structure that traps red blood cells like fish in a net.

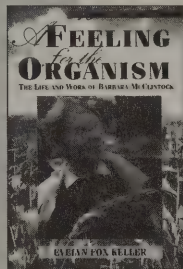
“ In a remarkable irony, these most visible differences in physical appearance—leading to much of the world's art, literature, and day-to-day thought—are controlled by the presence or absence of a single methyl group. The two methyl bumps on testosterone mean “man,” the single methyl bump on estradiol (an estrogen) means “woman.”



**A Feeling for the Organism**  
The Life and Work of Barbara McClintock

Evelyn Fox Keller. 1993; 235 pp. \$15.95. W.H. Freeman.

A good biography offers the richness of psyche in history. Keller has given us that richness. **A Feeling** can be read as the life story of a woman who was unfairly shunned, isolated, and questioned at many moments, but whose love of her work (the cytogenetics of maize) was as much a vision quest as a scientific pursuit. It can be read as a history of the genome, especially the meandering meanings of “gene,” and, through McClintock's eyes and Keller's writing, one of the best scientific histories. By the end, we cheer her Nobel Prize, though we know her personal rewards of discovery dwarf the prize, and we wonder whether her still-controversial insights about learning on the molecular level may be prophetic. Corn has had no greater admirer since Kokopelli played his flute. —PW



actually felt as if I were right down there and these were my friends....As you look at these things, they become part of you. And you forget yourself. The main thing about it is you forget yourself.”

A hundred years ago, Ralph Waldo Emerson wrote: “I become a transparent eyeball; I am nothing; I see all.” McClintock says it more simply: “I'm not there!” The self-conscious “I” simply disappears.

“ What she soon saw was that by studying the geographical distribution of particular chromosomal types, once again she began to discern patterns. And she recognized that from these patterns, it would be possible to trace the patterns by which people settled and traded in the Americas; that is, a reconstruction of the biological history of the maize plant would permit a reconstruction of the migratory history of

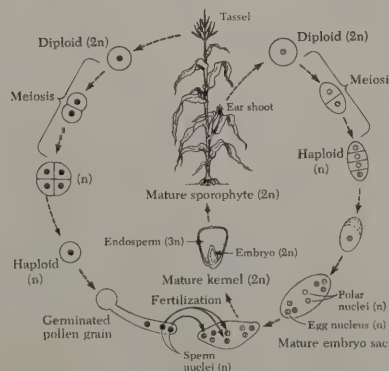
humans. The crucial point is that, unlike other grains, corn grows only where humans live. Because the corn seeds are tightly enclosed in the husk, the plant's propagation is entirely dependent on human intervention. Therefore, when McClintock saw that the variations in chromosomal constitution fell into a geographic pattern, reflecting successive rounds of hybridization, she knew that the data would be of enormous interest to anthropologists.

“ Without question, the genetic apparatus is the guarantor of the basic stability of genetic information. But equally without question, it is a more complex system, with more complex forms of feedback, than had been previously thought. Perhaps the future will show that its internal complexity is such as to enable it not only to program the life cycle of the organism, with fidelity to past and future generations, but also to reprogram itself when exposed to sufficient environmental stress—thereby effecting a kind of “learning” from the organism's experience. Such a picture would be radical indeed, and it would be one that would do justice to McClintock's vision: it would imply a concept of genetic variation that is neither random nor purposive—and an understanding of evolution transcending that of both Lamarck and Darwin.



Barbara McClintock's graduation portrait, Cornell University, 1923.

The life cycle of corn.



“ Where before she had seen only disorder, now she could pick out the chromosomes easily. “I found that the more I worked with them the bigger and bigger they got, and when I was really working with them I wasn't outside, I was down there. I was part of the system. I was right down there with them, and everything got big. I even was able to see the internal parts of the chromosomes—actually everything was there. It surprised me because I



“Infrastructure” first appears in French dictionaries in 1875 for the bedding of a railroad tracks (under the structure but supporting it). Quickly, humans extended the word’s meaning to describe all railroad facilities, then military facilities, and then civil engineering or public works that provide goods and services. In 1911, French Marxists adopted the word to describe the hidden facts of society from which all ideology and politics allegedly emerge (the superstructure). Infrastructure still retains this sense of invisible phenomena that sustain a perceivable reality. Buried underground and connected to facilities and installations hundreds of miles from the point of final use, our infrastructures are essentially invisible. What powers the TV? What causes electric current to be here now? Few can answer this simple question. It’s basically an “out-of-sight, out-of-mind” attitude. Because of its association with Marxism, “infrastructure” did not appear in major British and American dictionaries until the late 1960s. Then it blossomed into a word to build dams, roads, power plants and electric utilities, clinics, and jails that will make the Third World grow up to be just like us.

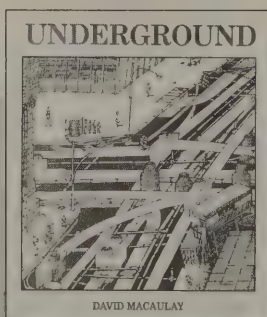
Infrastructures harbor remarkable power. They spread far and wide over landscapes. They become a prerequisite of conquest and government survival. Once in place, they seem to have a life of their own. Technocrats and bureaucrats spend their whole careers tending them. When Chernobyl blew, citizens finally lost faith in Soviet governance of the nation’s health and power infrastructure. A failure in this one part of the infrastructure brought down the whole government.

This section begins to dig into the bedding. Aldo Leopold, Witold Rybczynski, Malcolm Wells, Hardin Tibbs, and Paul and Julie Mankiewicz probe infrastructure’s psyche and mindset. Amory Lovins describes one reason why it’s so hard to build ecologically aware infrastructures. The clash continues between those promoting megaprojects and those advocating deconstruction of dams, nukes, levees, and roads. Both claim to benefit economics, environmental health, and life itself. The search is on for a humane infrastructure or, with a big heart, a soulful ecostructure. ⊕

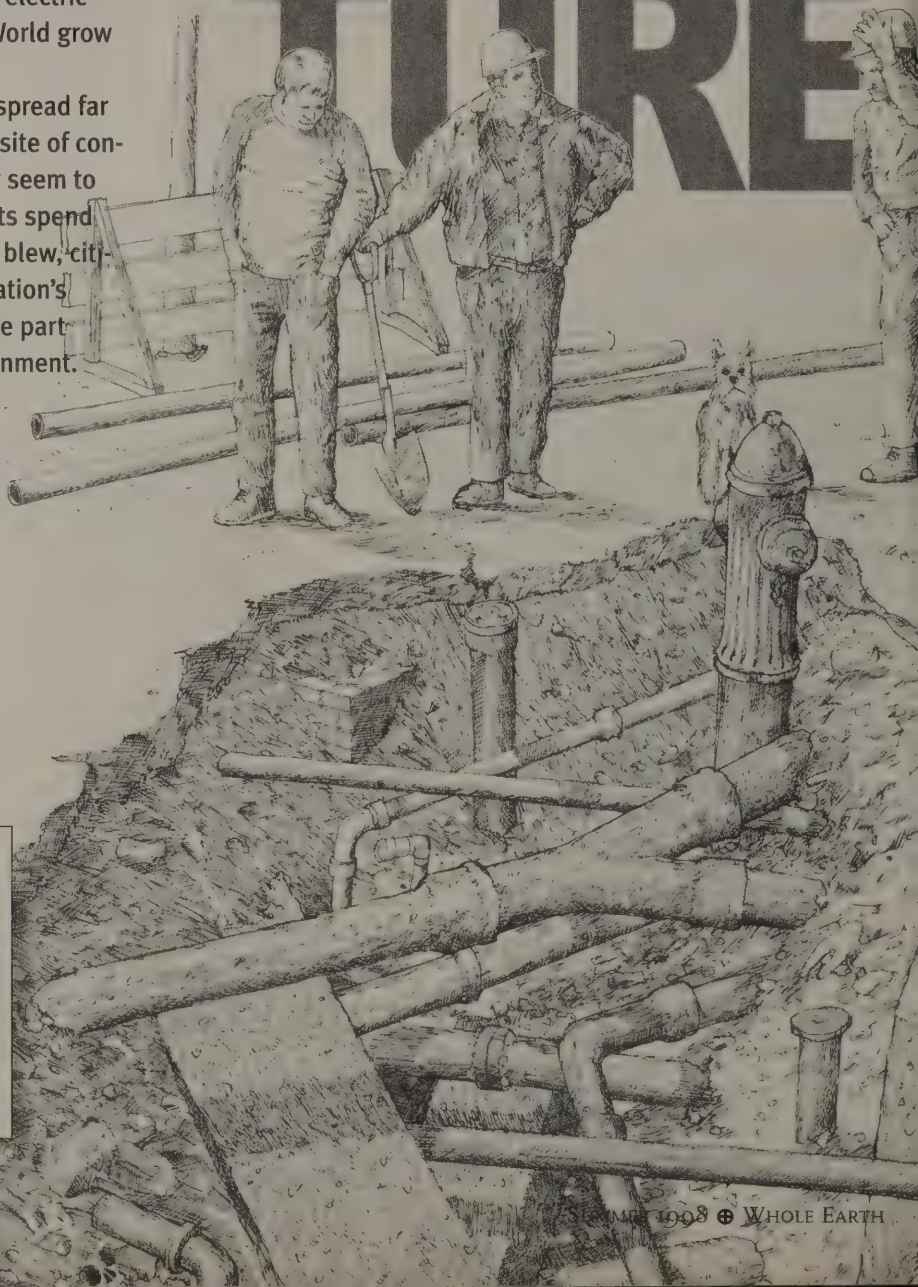
### Underground

David Macaulay. 1976; 112 pp.  
\$8.95. Houghton Mifflin Company.

It’s the best urban infrastructure book ever. For kids, adults, rats, and alligators. Beautifully drawn. —PW



# Humane INFRA STRUC TURE





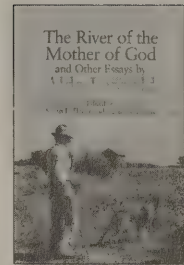
# ENGINEERING & CONSERVATION [1938]

ALDO LEOPOLD

**AT** THE PRESENT MOMENT, the word “engineer” in the minds of some conservationists is associated with an attitude toward natural resources which they dislike. It evokes in them a mental image of marshes needlessly drained, of rivers expensively channelized to revive an expiring navigation, of floods aggravated by stream straightening and by constraining levees, of irrigation reservoirs silted before the maturity of their bonds, and of a veritable mycelium of roads at least a part of which are built regardless of cost or need.

This tendency to challenge the engineer is admittedly confined to that small group preoccupied with the biological aspects of public policy....We may perhaps strike at the root of the matter by this generalization: the engineer believes, and has taught the public to believe, that a constructed mechanism is inherently preferable to a natural one. The conservationist believes the contrary.

The Mississippi dams involve a more subtle issue. That the great river is sick all will agree. Treatment can be applied either to the channel where the symptoms are most conspicuous, or to the deranged watershed which gives rise to the symptoms. The engineers started to bandage the channel with steel and concrete before giving ear to the question of what ails the organism as a whole. The case of course involves many other



THIS PIECE WAS EXCERPTED FROM *THE RIVER OF THE MOTHER OF GOD AND OTHER ESSAYS*. ALDO LEOPOLD, SUSAN L. FLADER, AND J. BAIRD CALLICOTT, EDs. 1991; 384 PP. \$29.95 CLOTH, \$14.95 PAPER. UNIVERSITY OF WISCONSIN PRESS, 800/829-9559. COPYRIGHT © 1991, THE ALDO LEOPOLD FOUNDATION. REPRINTED BY PERMISSION OF THE UNIVERSITY OF WISCONSIN PRESS.

Onokami  
Village, Gunma  
Prefecture,  
Japan, 1994.

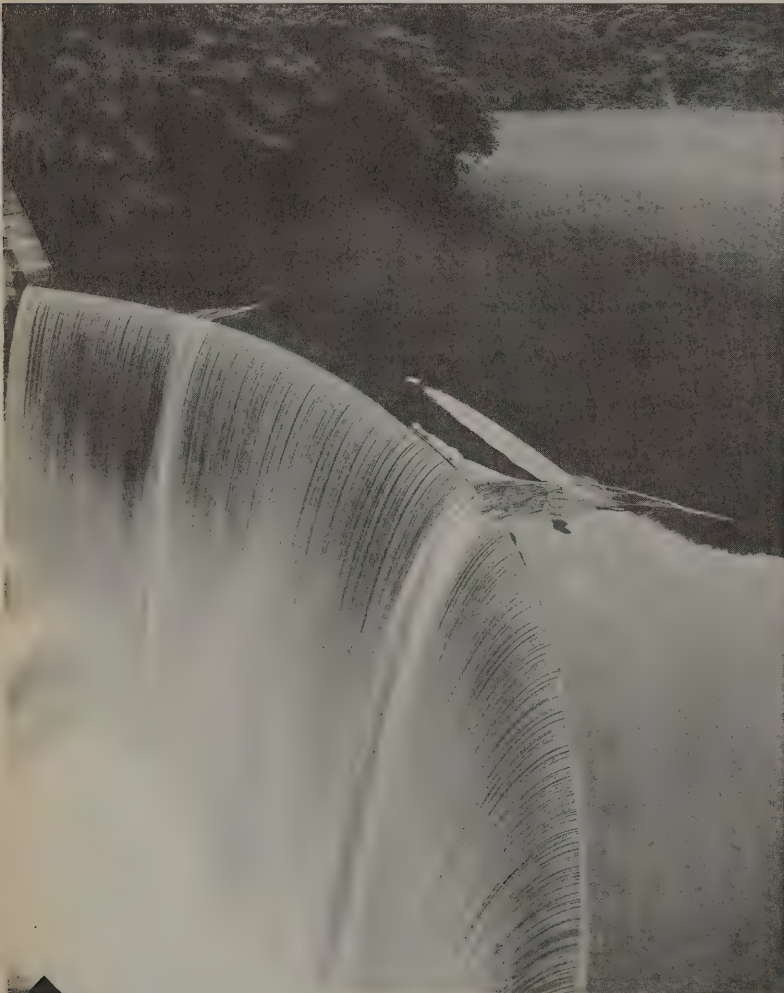






PICTURES ON PAGES 45-46 FROM *LANDSCAPE*, BY TOSHIO SHIBATA. 1997, NAZRAELI PRESS, 1955 WEST GRANT RD., STE. 230, TUCSON, AZ 85745. ALSO ON EXHIBIT AT THE MUSEUM OF CONTEMPORARY ART, CHICAGO, IL, 1997-98. TOSHIO SHIBATA MAKES EVERY LAND FORM HE POINTS HIS CAMERA AT BEAUTIFUL AND INTRIGUING. WE THINK YOU'LL AGREE, AFTER YOU CATCH YOUR BREATH, THAT HIS APPRECIATION FOR THE SENSUALITY OF STRUCTURE IS IRRESISTIBLE.

Kashima Town,  
Fukushima  
Prefecture,  
Japan, 1990.



TOSHIO SHIBATA

issues which I do not here discuss. I point out merely the seeming assumption that skillful structures can solve our water problems, and (by implication) exempt us from the penalties of bungling land use.

When some inventor comes out with a new alloy the engineers lose no time making a path to his door. But discoveries outside the engineering field may have an equal bearing on the responsibilities of the engineering profession. Take, for example, Lowdermilk's formulation, in terms of physical chemistry, of the basic mechanism by which plants influence runoff. This reorients the old controversy about the influence of forests and presents a challenging opportunity for joint research by soil chemists, engineers, and botanists. But who is doing such research? I here criticize all three parties for inaction.

What I here decry is not so much the prevalence of public error in the use of engineering tools as the scarcity of engineering criticism of such misuse. Both professions [the engineer and the chemist] exemplify priority for the synthetic over the natural, a certain atrophy of esthetic discrimination, a yearning for prosperity and comfort at any cost. I do not claim that we, the disaffected, disdain the prosperity and the comforts. Our only contribution is the idea that the cost is large, unnecessarily large.

The engineer has respect for mechanical wisdom because he created it. He has disrespect for ecological wisdom, not because he is contemptuous of it, but because he is unaware of it. We have, in short, two professions whose responsibilities for land use overlap much, but whose respective zones of awareness overlap only a little.

This may prove less difficult than appears on the surface, for the ecologist is in many ways an engineer. The biotic mechanism is too complex to enable him to predict its reactions; therefore he advocates what an engineer would in like case: go slow, cut and try.

[The ecologist] feels an engineer's admiration for this complexity which defies science, and an engineer's aversion for discarding any of its parts. The real difference lies in the ecologist's conviction that to govern the animate world it must be led rather than coerced. To me this is engineering wisdom; the reason the engineer does not display it is unawareness of the animate world.

The tools which the engineer has given the public are so crude and powerful that they invite coercive use. It is not likely that the public will lay them down. The only alternative is the pooling of engineering and ecological skills for wiser use of those tools. Is this pooling under way? Perhaps. We now see engineers and ecologists jointly attacking the soil erosion problem but only after the resource reached an advanced stage of deterioration. Need we always await the willy-nilly pressure of wrecked resources before professional cooperation begins?

We end, I think, at what might be called the standard paradox of the twentieth century: our tools are better than we are, and grow better faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it. ⊕

Our tools are better  
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of land without  
spoiling it.

Aldo Leopold was and remains the finest thinker on American conservation, with the most precise, crafted, thoughtful prose. *A Sand County Almanac* (Millennium Catalog, p. 65) is his classic.



The Edifice Complex dies hard. Some civil engineers dream that bigger and quicker must be better and will swear on a stack of Bibles that unbounded engineering stimulates growth and commerce and is good for human welfare. Look at all that wondrous infrastructure, even of the dead: the pyramids! So dig deeper, carry greater volumes of water and gas for longer distances,

connect every highway on the planet with longer tunnels and bridges and wider highways, construct more and larger dams and aqueducts, mine the moon, wire the globe and everyone's income and happiness will improve. It's not over. Here are "structurophilia" dreams. Governmental largess, taxpayer subsidies, and nary an environmental impact.

# MEGAPROJECTS



## Water Projects

- Jordan Valley Desalinization: a canal from either the Mediterranean or the Red Sea to a Jordan Valley desalinization plant.
- The Great Anatolia Pipeline: Turkey's \$32 billion irrigation and hydropower generation project, including twenty-one dams, seventeen hydroelectric plants, and a network of canals to irrigate 14.2 million acres of land.
- Libya-Sahara Aquifer water project would take water from aquifers under the Sahara Desert and deliver it by aqueduct to reservoirs in coastal Libya.
- Narmada River Valley Dam Complex: a big dam in India. A lot of dams—thirty major and thousands of small- and medium-sized ones—in an Indian river valley. Maheshwar is the most notorious—it would submerge sixty-one villages. Everyone protests but the engineers carry on.
- The Paraguay/Parana Hidrovia Waterway Project would modify this enormous South American drainage system, including making 3,400 kilometers of the river navigable for ocean-going vessels from the Atlantic to Caceres, Brazil.
- Yangtze River Dam Projects (See Whole Earth No. 92): 600-foot-high dams; 400-mile-long reservoirs; 1.9 million people displaced.
- Canada-to-California Project: too many people in California committing too much water-intensive agriculture? And all that water going to waste on a few caribou and beavers north of the border? Here's a plan...
- James Bay Hydroelectric Dam complex: Hydro-Quebec's project that won't die. On-again, off-again since the 1970s, it calls for converting a watershed the size of France into a string of reservoirs and electricity farms.
- The Bakun Dam in Sarawak, Malaysia: a \$5.5 billion privatized project that threatens 10,000 indigenous people. Recently "delayed indefinitely."
- Atlantic-Pacific Canal through Nicaragua.
- Brahmaputra/Ganges Canal.

## Transportation Megaprojects

- Chunnel: thirty-one-mile-long (twenty-three miles under water) rail tunnel from the British Isles to the European mainland, completed in 1994.
- Denmark's Great Belt and Scandinavia-Europe Tunnel-and-Bridge Complex: bridges and tunnels connecting Denmark's two main islands are part of a bridge/tunnel scheme to link Scandinavia with Europe, including Copenhagen-Malmö, Sweden and Denmark-Germany. Can EMU Vikings be far behind?
- Bering Strait Tunnel: as long ago as 1906, a Russian-French-American consortium had \$6 million on deposit for construction of an Alaska-to-Russia tunnel. The latest dreamers envision a tunnel from Wales, Alaska to Uelen, Russia, along with construction of 4,800 miles of additional rail line. All aboard in Mexico City. Next stop: Moscow.
- Gibraltar Crossing: Forget about buying a piece of the Rock. It's soon to be a toll plaza on the road to Morocco.
- North-and-South Island Crossing (New Zealand): a plan to connect either the North to the South Island or the South to the North Island.

## Telecommunications

- Africa ONE Project: Plan to encircle Africa with submarine fiber-optic lines, with more than forty landing points in Africa.

## Energy & Minerals

- Mahgreb-Europe Gas Pipeline: to run from Cordoba, Spain, to Hassi R'Mel, Algeria.
- Various global power grids.
- Deep mining: warm your toes on heat energy straight from the Earth's core.
- Deep mineral deposits: one project has already found deposits ten kilometers below the surface in Siberia.

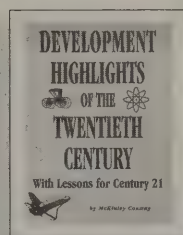
## Biosphere Protection

- Diversion of ocean currents: create new fishing zones, modify climate change, build new resorts.
- Bubble architecture for cities and bubble farms for agriculture. Biosphere2's children.
- Proposed tent structures to alter the climates of low-lying Japanese islands.
- Asteroid diversion program.
- Lunar Economic Development Authority: a 1996 proposal to create a development plan for the moon. Save the Earth. Go to the moon.

## Development Highlights of the Twentieth Century With Lessons for Century 21

McKinley Conway, 1997; 114 pp. \$24.  
 Conway Data, 35 Parkway, Suite 150, Norcross, GA 30092. 800/446-6996, fax 770/263-8825, info.mgr@conway.com, www.conway.com.

Development Highlights includes a timetable for the predicted completion of many of these projects (for a shorter version, see the March, 1998 *Futurist*). Conway Data's GeoFax service (770/453-4200) offers fax delivery of papers detailing these and other global superprojects.

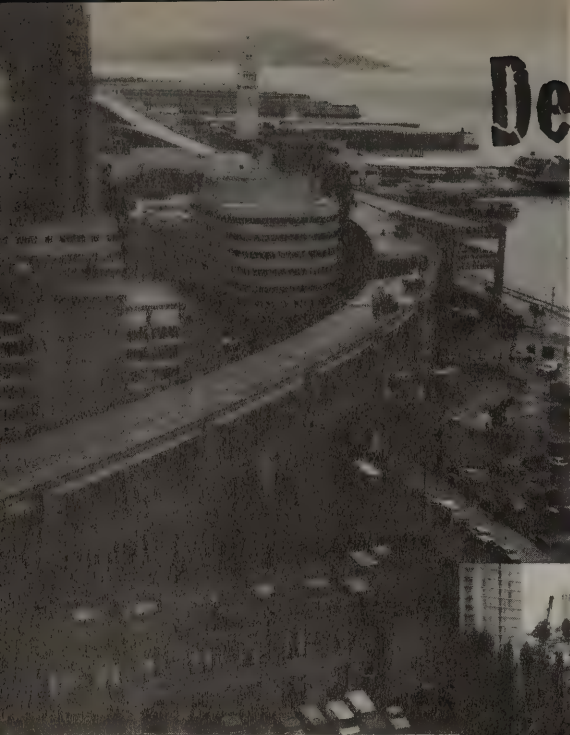


Using the Great Global Highway, a Scandinavian family might one day drive across Europe, around Africa, along a new "Silk Road" to China, across the Bering Strait, and down the Pan American Highway to South America.





# Deconstruction that Improves Your Life



The late not-so-great Embarcadero Freeway was damaged in the 1989 Loma Prieta earthquake. The city of San Francisco decided to finish the deconstruction. The results: new access to the downtown waterfront, skyrocketing real estate values, and a popular pedestrian walkway.



PHOTOS COURTESY OF CALTRANS



## Deconstructing Levees

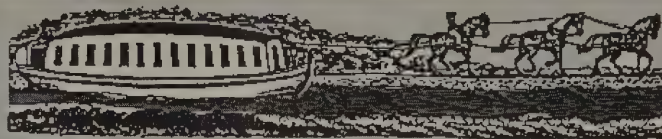


PORT OF TACOMA AUTHORITY

The deconstruction of levees and dikes has become reasonable, if not wealth-enhancing. The photo on the left shows the breaching of a dike along the Puyallup River at Tacoma, Washington. The river had been channelized and wetlands lost. To restore this wetland, 55,000 cubic meters of solid waste landfill had to be excavated, a buried oil pipeline was re-routed, and a new dike was built to surround the old system. Juvenile salmon now have a place to feed and hang out before heading to the Pacific. The question remains: should we keep managing the new ecosystem for salmon or allow it to transform into a marsh?

Infrastructure can backfire and harm human welfare rather than help it. Infrastructures can accelerate exploitation; discourage use of ecostructures that could have performed the same job with greater human enjoyment and less environmental damage; bury citizens in grave financial debt; encourage engineers to sell a product rather than solve a problem; promote wasteful uses; and blind the public to conservative use, recycling, and efficiency.

So some cities and citizens rebel. Aided by earthquakes, San Francisco abandoned the idea of reconstructing another freeway. Aided by quicksand and decrepitude, New York took down its West Side Highway and gentrified the Hudson shoreline. In Ontario and Montreal, deconstruction thrives. Now the licensing commission that oversees hydropower has ordered the Kennebec Dam in Maine to be removed because letting the fish run is a better idea. Sixteen dams are already gone and a dozen more will probably go. The dam deconstruction industry looks like a growth business. Nuclear reactors, which are notoriously costly to run and insure, are closing down at a rate of about one a year! Some levees built to hold back the Mississippi are now left open and towns have moved instead. Florida's Kissimmee River, once channelized, is now being re-meandered by the Army Corps of Engineers—one of its largest projects. Now if we could deconstruct certain Ivory Towers, real deconstruction of harmful infrastructure might just become a fad.



## Old Infrastructures, New Flows

Once established, the connectivity and configuration of infrastructures influence centuries of human history. After Roman roads, the canal system became Britain's first nation-wide (or almost) communications network. Their towpaths, once used by horses to pull barges along the canals, have recently been converted into the pathways for fiber-optic cable. The new use of the towpaths has, in turn, reinforced the historic value of the old canal system, even though no one uses horse-drawn barges.

Burying the fiber-optic cables under the towpaths seemed a much better option than burying them in roads that are stuffed with other utilities. In addition, Brits settled near the figure-eight-shaped canal system about 200 years

ago. Many of the settlements grew because of commerce. This earlier pattern of urbanization set the stage. Today, sixty percent of Britain's population live within eight kilometers (five miles) of a canal, making it economical to lease the towpath right-of-way from Britain's Waterways Board. Fibreway, a company that manufactures telecommunications equipment, offers cable with the capacity of 32,000 simultaneous phone calls and 400 digital TV programs.

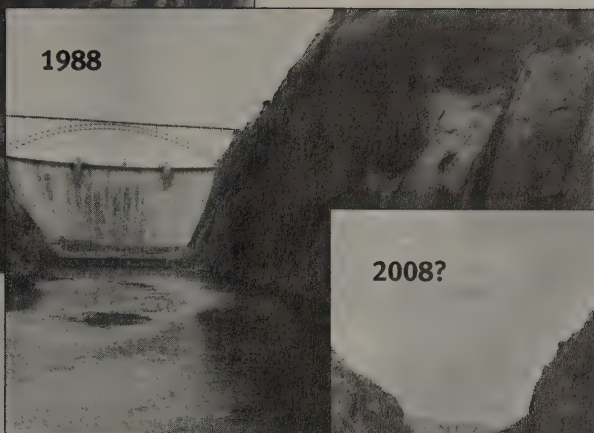




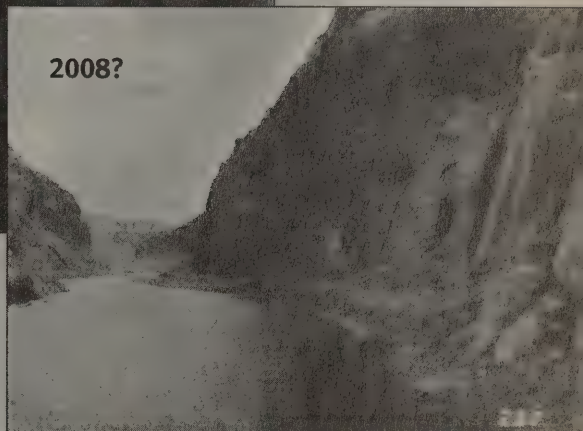
1888



1988



2008?



The deconstructionist dream of river lovers. Glen Canyon and Glen Canyon Dam. Dam photo by Robert Webb.

## Deconstructing Deadbeat Dams

### Removed Dams

*North Carolina:* Quaker Neck Dam, Neuse River (non-hydro)

*Vermont:* Newport 11 Dam, Clyde River (FERC hydro)

*Wisconsin:* 14 small dams (non-hydro)

### Dams Committed for Removal

*Maine:* Edwards Dam, Kennebec River (FERC hydro)

*Wisconsin:* Woods Creek Dam, Woods Creek (non-hydro); Pine Dam, Pine River (FERC hydro)

*Michigan:* Sturgeon Dam, Sturgeon River (FERC hydro); Stronach Dam, Pine River (FERC hydro)

### Dams Under Active Consideration for Removal

*Maine:* Great Works Dam, Penobscot River (FERC hydro); Brownville Dam, Pleasant River (non-hydro); Souradabscook Dam, Souradabscook River (FERC exempt hydro)

*New York:* Station 160 Dam, Genessee River (FERC hydro)

*Florida:* Rodman Dam, Ocklawaha River (navigation)

*Colorado:* Glen Canyon Dam, Colorado River (federally-owned hydro)

*Washington:* Condit Dam, White Salmon River (FERC hydro); Elwha and Gines Canyon Dams, Elwha River (FERC hydro); Four Army Corps dams, Lower Snake River (federally-owned hydro)

*Oregon:* Savage Rapids Dam, Rogue River (water diversion)

*California:* Ringe Dam, Malibu Creek (southernmost run of steelhead)

### Hydropower Reform Coalition or American Rivers Hydropower Programs

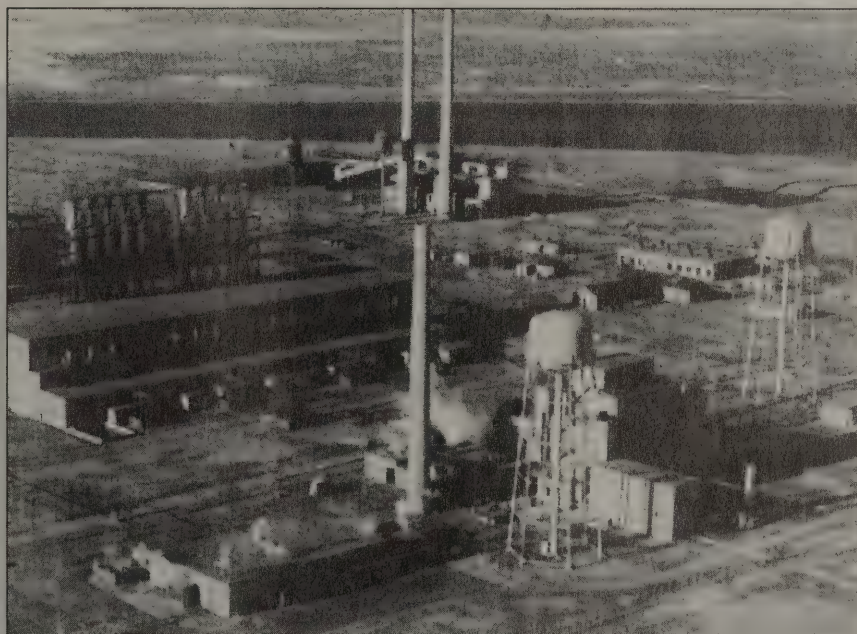
Both at 1025 Vermont Avenue, NW, Suite 720, Washington, DC 20005, 202/547-6900, fax 202/347-9240, HRC email: [hrc@jgc.apc.org](mailto:hrc@jgc.apc.org), American Rivers: [margaretb@amrivers.org](mailto:margaretb@amrivers.org).

## Decommissioning Nukes

There are 104 nuclear reactors operating in the US today. Twenty-four have been shut down, eight of those since 1990. Studies predict forty percent of our nuclear plants will be retired early (in the next seven to ten years), before their licenses expire.

Enviros and deregulators have dealt the final blow. With a more competitive economic squeeze in the energy supply field, utilities want out fast and cheap. But when companies start losing their profit margin it is a dangerous time to attempt to decommission responsibly. They (along with Al Gore and the Association of Radioactive Metal Recyclers) promote "rapid dismantlement" or "early component removal," and we find abandoned plants, leaky casks, and waste sites built in environmentally unsound or fragile territory. Or in the backyards of poor minority citizens.

So what is the "proper" solution? A whole new waste management infrastructure must be conceived and built. The fantasy is to convene a Manhattan Project Two, bringing together the brightest minds, with no cost cap, to come up with better and best means of dealing with the dangerous radioactivity that remains. And, stopping operation of all facilities right now would reduce the waste we'll have to deal with by two-thirds. —ET



Hanford's B Reactor Building, c. 1945, has been nominated for the National Register of Historic Places. It was designated a Landmark of the American Society of Mechanical Engineers in 1976.

### Reactors Closed since 1990

*Maine:* Maine Yankee; Wiscasset, December 1996

*Massachusetts:* Yankee Rowe; Rowe, September 1991

*Connecticut:* Haddam Neck; Haddam Neck, December 1996

*Illinois:* Zion I and II; Zion, January 1998

*Missouri:* Big Rock Point; Charlevoix, August 1997

*Oregon:* Trojan; Prescott, November 1992  
*California:* San Onofre; San Clemente, November 1992

### Nuclear Information and Resource Service (NIRS)

1424 16th NW, Suite. 404, Washington, DC 20036. 202/328-0002, fax 202/462-2183, [nirsnet@jgc.org](mailto:nirsnet@jgc.org), [www.nirs.org](http://www.nirs.org).

Fierce watchdogs for all nuclear junkyards, NIRS synthesizes knowledge into wisdom, creating powerful political pressure.







NANCY WOLF, THE PAST HAS NO FUTURE, 1990, CARBON PENCIL ON PAPER. COURTESY OF MARSHA MATEYKA GALLERY, WASHINGTON, DC.



## F A Ç A D E S

*“Work expands to fill the time available for its completion, and subordinates multiply at a fixed rate, regardless of the amount of work produced.”*

Remember Parkinson's Law? It was formulated in 1958 by Cyril Northcote Parkinson, an obscure British political scientist who was then teaching at the University of Malaya in Singapore. When I read Parkinson's book, sometime in the mid-sixties, it was already a classic. I don't remember what prompted me to buy a copy—I was studying architecture, not politics. Most of the book dealt with business organization, albeit with tongue in cheek. “Heaven forbid that students should cease to read books on the science of business administration,” Parkinson advised, “provided only that these works are classified as fiction.”

One chapter, titled “Plans and Plants, or The Administrative Block,” did deal with architecture. I remember it since it undermined much of what I was being taught in my classes. Parkinson's thesis, briefly put, was that when an organization commissioned an architectural masterpiece for itself, it was almost always done at precisely the moment when that organization was on its last legs. “During a period of exciting discovery or progress there is no time to plan the perfect headquarters,” he wrote. “The time for that comes later, when all the important work has been done. Perfection, we know, is finality; and finality is death.”

Parkinson backed his argument with examples. St. Peter's in Rome appears to represent the perfect home for the papacy at the height of its powers. In fact, it was not built by such exemplary popes as Innocent III or Gregory VII (St. Gregory), but much later by popes who were enmeshed in worldly affairs and had lost much of their moral authority. The Palace of Versailles appears the neoclassical quintessence of Louis XIV's monarchy. In reality, the Sun King only lived there several decades after his great military triumphs and at a time when his power was in decline. The British built New Delhi as the perfect Imperial capital. The year after the Viceroy moved into his new palace, the Indian Congress demanded independence and began the chain of events that led to the dissolution of the Raj.

A final example: the Pentagon. A perfect embodiment of American military prowess? “It was not completed until the later stages of World War II,” Parkinson points out, “and, of course, the architecture of the great victory was not constructed here, but in the crowded and untidy Munitions Building on Constitution Avenue.” So, the five-sided office complex is properly associated with less glorious military conflicts: Korea, Vietnam, and Grenada.

The idea that great works of architecture really are façades for crumbling institutions, and that the architect is a kind of bricks-and-mortar spin-meister, was a disturbing one for an architectur-

al tyro. It continues to nag at me. Over the years I have come across many examples that support Parkinson's contention that “perfection of planning is a symbol of decay.” CBS was once the country's foremost news organization. By the time it built its imposing black granite headquarters in Manhattan, Edward R. Murrow was gone and infotainment was just around the corner. Pan American Airways did not build its huge headquarters on Park Avenue until long after it pioneered transoceanic air travel—and not so long before it ceased operations. In 1962 TWA, which had been one of the country's “Big Four” airlines, completed what is perhaps the most striking airport terminal ever built, Eero Saarinen's bird-like structure in New York; less than twenty years later, the airline was on the edge of insolvency, and now exists in a much-reduced state. In 1981, steel was being erected for a new IBM headquarters office tower on Madison Avenue. That was the same year that IBM introduced its first PC, with a microprocessor manufactured by Intel and an operating system licensed from a small Seattle-based company called Microsoft. By the mid-1990s, IBM was in deep financial trouble and selling its art collection; Intel was the world's largest chip manufacturer, and Bill Gates was the richest man in America. Did IBM learn its lesson? Last year Big Blue moved into yet another new home. According to *Architecture* magazine, the dramatic building “mirrors the transformation of Big Blue into a company predicated on change.” Want to bet?

It is always easier to build an impressive building than to build—or rebuild—an impressive organization or institution. There is a corollary to Parkinson's Law. Just as perfect buildings mask decaying institutions, a new institution that starts life by building a perfect building risks choking itself. There is a recent tragi-comic example. The American Center in Paris set out to make its mark by hiring the celebrated architect Frank Gehry to design its new building. Gehry delivered a characteristically striking design. It was perfect: it won awards, the architectural critics loved it, it made the American Center an overnight sensation. The problem was that the construction was expensive, indeed, so expensive that the building stood empty for months after it was finished. The American Center for Paris is now up for sale. Only ailing organizations need apply. ⊕

*When an organization commissions an architectural masterpiece for itself, it is almost always done at precisely the moment when that organization is on its last legs.*

Our favorite city-ologist, Witold Rybczynski, is Meyerson Professor of Urbanism at the University of Pennsylvania and co-editor of the *Wharton Real Estate Review*. His most recent book is *City Life*.





Malcolm Wells

# How to Celebrate Underground America Day

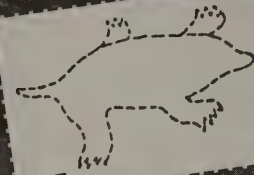
Dig a hole and put your house in it. Cover it up.



Touch a basement wall.



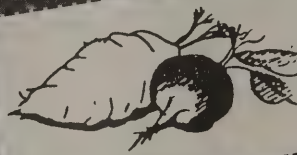
Think about moles



Ride the subway with a friend.



Eat a parsnip or radish.



Stay home from work and put some dirt on your roof.

Two ingredients are crucial to great poets: vividness and candor. Here, we find them in an architect who takes his own photos, sketches and paints his own designs, writes his own text, and gadflies a profession that has asphalted the planet and promoted the design of oddball buildings that pride themselves on being contrary to Nature herself. Malcolm Wells writes for any citizen who humorously and practically wants to re-green the planet and restore both its photosynthetic powers and beauty. Malcolm takes Nature's underlying life support (soil), covers all sorts of human-built infrastructure (buildings, highways, airports) with dirt, then plants them. A poetic, practical architecture. Isn't that the heart of our Earthly desires for home? The mark of a remarkable man. *Infra Structures* (WER No. 85) and other books are available from Malcolm Wells, Box 1149, Brewster MA 02631, 508/896-6580. Every May 14th, he writes, "hundreds of millions of people all across this great land will do absolutely nothing about the Underground America Day I declared in 1974, and that's the way it should be. It's a holiday free of holiday obligations." —PW

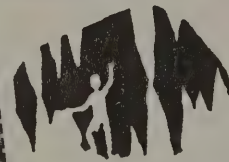
Bury some treasure.



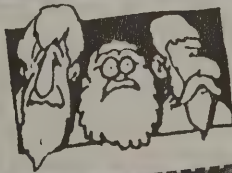
Listen to a Chinese conversation through the earth.



Get lost in a cave for 11 days; (When you're found, be sure to say, "Happy Underground America Day!")



Have a Malcolm Wells look-alike contest.



Hold a parade under Main Street.



Look down a well.



Bury the Pentagon.

And finally, draw a set of plans for an above ground building — but don't build it...





# Lock-In



## An Interview with Amory Lovins

**Amory Lovins:** I am told by an historian of science that this story may not be absolutely right in every detail, but the general drift of it is right. Why is the American rail gauge four feet, eight-and-a-half inches? Because our rail-ways were built by the British railway builders who used that gauge. They used it because before trains, trams had used that gauge. Trams used that gauge because trams were built by the wagonwrights who didn't want to have to change their jigs and tools when they switched over from making wagons to making trams. The reason wagons used that gauge is because, if the wagon wheels didn't fit the ruts in the long distance roads in Europe, they would of course tear themselves to pieces. So, where did the ruts come from? Well, the people who built the roads, namely the Romans. The moral of the story is: specs and bureaucracies live forever. The next time you're handed some spec and you ask what horse's ass designed this, you may be exactly right because the chariot wheel gauge of the Romans was designed to fit the back ends of two Imperial Roman Army war horses.

In fact, you find amazing anomalies even into modern times. Somewhere in Europe, just a few years ago, they still had a tapering section of adjustable track. The wheels would slide back-and-forth on the axle so that you had rail cars that could span two different standards. You would slowly go over this tapering stretch of rail. It would adjust your wheels to the new gauge and then you'd continue on into a new country. So the Romans may not have reached everywhere. Their lock-in was almost totally complete.

A classic example of modern technological lock-in involves things like VHS which got to markets in high volume earlier than Beta Max and therefore got such a large installed base of equipment that it beat out the technically superior Beta.

**Peter Warshall:** *So the moral of that story is that "earlier, not necessarily the best product or device, gives the competitive advantage."*

That's right and that's a pretty well-known conclusion among the more modern economists who think about expanding a set of diminishing returns to scale. That's a fairly common theory.

Lock-in has this dynamic quality. The more there is of it, the more dominance it gets. It is because there is so much of it, not simply because it's so expensive to replace one product with another or one infrastructure by another. The reason



the VHS took over was that, as there got to be more VHS tapes and players, it was easier to make new tapes in the format that would fit most of the players than to try to maintain multiple formats. And the more of them there



were the stronger that argument became. It was self-reinforcing. The positive growth feedback aspect makes it a lock-in.

Cellular phone standards would be another good example of industrial lock-in. There are a whole slough of choices: CDMA, TDMA, GSM and others. The cellular phone type called CDMA, in principle, gives you higher spectral density or channel per unit of spectrum. That simply means that you can handle more calls in a given spectrum than TDMA or GSM, or than analog amps.

In this country, we have three or four competing standards for cellular phones. We're in this incoherent period in the US where it's hard to get investors excited about one given standard because they're betting that any one could get crowded out by factors possibly quite beyond their control and who gets crowded out may not depend on technical merit. CDMA, for instance, is expected to grow faster because of its ultimate technical advantage, but it's been slow to take off because it's a late starter, and there's already such a big analog installed base.

Now in Europe, because the European Union needed interconnectivity and roaming, to be transcendent across many national boundaries, they went for GSM cellular phones early. Then a

lot of the rest of the world adopted them because there was already such a huge installed base of GSM phones. You gained economies of scale. The more phones you made to a given standard, the cheaper they'd get. They'd out-compete the others and people would say everybody seems to be switching to that standard, so I'll use it. So GSM, which is probably not as good in principle and certainly not as fast as CDMA, is slowly coming into the US because we have so many business travelers that are willing to pay for that feature. It offers the potential of international roaming (international cellular phone calling). Of course, just to make it more complicated, the US adopted a different GSM frequency. No lock-in yet.

*Timing and "greenness" appear complex. If you're too early, it's too high a cost to the innovator. If you're too late, you're out of the competition. How do you start out being flexible and still keep the option of being the most materials- or energy-efficient, or the most appropriate for the future in some other environmental way? How do you do it?*

If you need technical standards, either formal or de facto, you start setting them early and building into them enough flexibility so that you can adopt better ideas later. But, try to avoid so much flexibility that you get incompatible multiple standards á la Java. [Java is a computer program that carries its own application instructions]. You have to get enough big players on board early that it becomes a de facto standard as Java was supposed to—might still, but it's not looking very good right now. You have to be very far-sighted and think: what are people going to use this for? Is the hardware and software environment going to be changed? How can I get as far out in front as possible and still make it realistic to implement?

Another kind of lock-in, an infrastructure lock-in, that's interesting has been choices of voltage and frequency on the electric grid. Once you standardize voltage, for instance, everybody makes the equipment to match it to their distribution system. But, there are interesting niche markets that avoid the locked-in infrastructure. You have 12-, 24-, and even 48-volt DC appliances and devices for marine and Rec Vehicles. That market starts to pick up when people go to photovoltaics and find it might be cheaper not to have an AC-DC inverter. Instead, they can go straight off from the photovoltaic cells to 12- or 24-volt storage (all DC). Then, of course, the whole debate gets overtaken by events. A response to photovoltaics is to make AC-DC inverters so cheap and so efficient that you can perfectly well imagine running them at cost-saving frequencies, say 40 kilohertz instead of 60 kilohertz, having much lower losses, and then even converting frequency or voltage to whatever you want at the other end.

North America changed frequencies from 25 to 60 in metro LA, Toronto, Montreal as late as the 1950s. It was a huge mass retrofit with specially equipped van fleets going door to door, neighborhood to neighborhood,



changing all the unused equipment. I ran into a few places in Wisconsin and Maine in the pulp paper industry that are on an old frequency, 40-hertz standard, so it's hellishly difficult to keep themselves supplied with motors. They're practically all customized, which is expensive. There are actually historical examples where



we still have, even in Manhattan, little islands of the old frequencies, the 25-hertz system.

*So again, in terms of the infrastructure of electricity, is there any way that one could design a kind of forgiveness or a kind of flexibility into the appliances or the configuration and composition of the power distribution that would allow the future to accomplish some of your efficiency goals?*

That's an interesting question because, of course,

Edison wanted DC and Westinghouse, who wanted AC, won. Westinghouse was a better marketer but technically Edison probably had a better idea. Until you have the adaptive technologies that make inter-operability between AC and DC both cheap and convenient, you do get locked out—especially if you're not the standard that happens to win early.

But a lot can change. For example, think of the number of things in your house that run on low-voltage DC.

Your house receives 240/120 volts AC from the grid but your doorbell and other devices can only use very low-voltage DC. So, a tiny transformer that is always sucking electricity and wastes standby power as heat does the job. It operates even when the doorbell isn't ringing. Anything electronic with a remote control, clock, timer or memory "vampires" electricity even when it's "shut off." These little power cubes typically eat three to five watts phantom load all the time whether they're in use or not (see box). That can easily be a tenth of the usage in your house. The US keeps something like five to eight gigawatts busy full time running stuff that's turned off.

So we already have an emerging dual standard of AC and DC. We just don't think of it that way. In fact, the

downstepping from 240 or 120 volts to "X" volts is not even standardized. The low voltage DC power cubes may be anywhere from five to 32 volts, depending on what the gadget is.

Power cubes are different in their voltage connector and current rates. They're also generally lousy in efficiency. In effect, something on the order of ten or twenty percent of the residential use electric market is already low-voltage DC in various voltages even though we're all fed from AC. We just take it for granted that

we're going to need a little power cube to adapt.

*So then if we put up a photovoltaic cell on the house, we could just go direct to DC?*

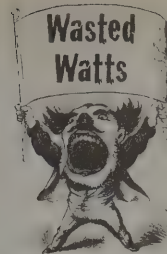
Yes, if there were a better voltage standard, if everybody would settle on 24 volts or whatever. The traditional reason for not doing it was: if you are drawing much current on a long circuit, you need a hell of a lot of copper. Otherwise, you experience a big voltage drop in low voltage. But, if you're using very efficient transmission lines the need for a big voltage may no longer matter. Second, the objection was that you would have to rectify the AC coming off the grid. But, if you're not using the stuff coming off the grid, who cares? And in general it's cheaper not to use the stuff off the grid. They're finding in Sacramento that it's cheaper to hook new alley lights to photovoltaics than to connect them to the wires that are

already in the alley. It's cheaper even in first costs, let alone the energy savings later.

*So much for lock-in. Here's a final question. When is it good to have a product with a short lifespan so you can innovate? When do you want to have one that has a long life span so that you don't do all of the things....*

Good point. For example, a car or refrigerator, if it's something that can't be retrofitted and its efficiency or other qualities are inflexible because it's fixed hardware, then you may want it to be highly recyclable. In the short run, until it's really refined, it should not be all that durable. On the other hand, if you've already got the fifty-fold more efficient refrigerator, which we do in the lab, then you ought to make it very durable.

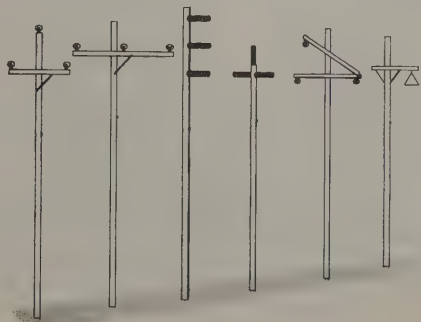
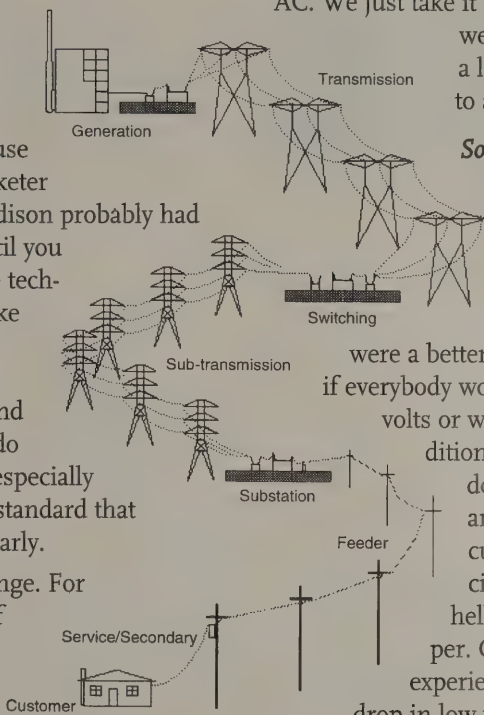
A good way to get the balance right is to lease the service rather than selling the object. I think we're moving toward that point. When you try to sell somebody a product, if they're smart, they'll say: "Why are you trying to sell this to me? There must be something wrong with it. If it has the operational advantages, you'd want to capture operational profits for yourself by only selling me the service. Why are you trying to palm this thing off on me and stick me with its operating and lifespan disadvantages?" There are commercial carpet dealers who already offer this service: carpets from recycled materials, replaceable worn-out carpet patches, long-term contracts. Cars of the future may follow the carpets. ⊕



- Security system 18
- Digital satellite TV 15
- Cable-TV box 12
- Compact radio 11
- Color TV 6
- VCR 5
- Door opener 5
- Microwave oven 4
- Cordless phone 3
- Answering machine 3
- Electric toothbrush 2
- Cordless tools 2
- Doorbell 2
- Baby monitor 1

Of the \$3.5 billion Americans spend on household electronic gear, \$1 billion is spent to power them when they're shut off. That's about six power plants, thirty percent of today's electricity use in households.

Amory Lovins carries in his head more comprehensive information about energy matters than most of us have on our bookshelves or at the local library. He's had heaped on him nearly every available award for environmental innovation. His "end-use/least-cost" redefinition of the energy problem literally changed corporate America and government policies. He, Hunter, and their iguana founded Rocky Mountain Institute, the gracious mountain palace of ultimate energy conservation. Amory's been a friend of Whole Earth's since the beginning. J. Baldwin hangs out at RMI. We honor Amory's thinking, and his backrubs, as elegant, precise, and detailed.





# Can We Drink the Water We Live With?

## New Yorkers Struggle to Let Nature Do the Job

**A**t the time of contact with Europeans in lower Manhattan, the water supply of the local Werpoes peoples came from a freshwater pond near where the Tombs now stands. The pond and marshes covered about forty-eight acres and were fifty to sixty feet at their deepest. "The Collect" in English (*Kalch-Hook* in Dutch) was fed by springs, which to this day erupt into cellars. The pond drained down a small channel paralleling Canal Street to the East River.

New York City now supplies about 1.4 billion gallons per day to some nine million users—a flow equivalent to a river about fifty feet wide and four feet deep moving at white-water speeds of more than ten feet per second. The

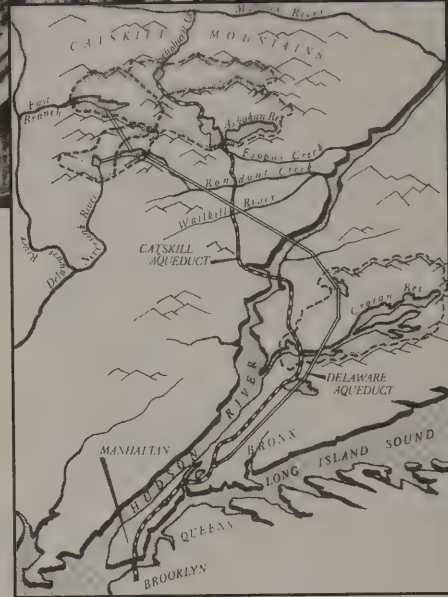
**Paul S. Mankiewicz**  
**Julie A. Mankiewicz**

Collect became polluted by horse and cow manure and couldn't provide adequate water to fight fires. Pressed by epidemics and costly fires, John Jervis began work in 1836 on a reservoir system in the Croton watershed. Initially delivering ninety million gallons per day from the Croton watershed, the Croton aqueduct was expanded in 1892 to 390 million gallons. After 150 years, the water remains remarkably pure and requires no filtration before supplying New York citizens.



But pure or not, it is the center of a controversy. The EPA has said that the Croton watershed is stressed from development and has sued New York to force them to build a billion-dollar water treatment facility for the Croton supply. A coalition of citizen groups and scientists say it's cheaper and safer to rely on well-stewarded soils and streams within the watershed. At the heart of the disagreement is a choice: an end-of-the-pipe billion-dollar filtration facility in a community of 50,000 residents and 25,000 students, or protection and enhancement of watershed ecostructures and functions. The question is what to trust: nature's diverse and widespread capacities, or one centralized technological filtration facility?

The Bronx Council for Environmental Quality, the Northwest Bronx Community & Clergy Coalition, Bronx and citywide housing groups, block and community associations, the Croton Watershed Clean Water Coalition, local and regional chapters of the Audubon Society, Trout Unlimited, and the Sierra Club, the Friends of Clearwater, land



Above: The New York City water supply comes from the Croton watershed, the Catskill Mountains watershed, and the Delaware River, by way of two tunnels under the Hudson River.

Left: The original water supply of Manhattan overlaid on today's street patterns.



trusts, and trail groups, among others, advocate a watershed maintenance and restoration program to insure that the Croton water quality remains top-notch. Connect street and land surface runoff with the soils and subsoils, wetlands, forests, meadows, and streams and let these ecostructures bio- and geochemically treat, filter, adsorb, and absorb pollutants and pathogens (the disease-causing organisms). Let nature do the purification work.

### The Soil/Watershed Alternative

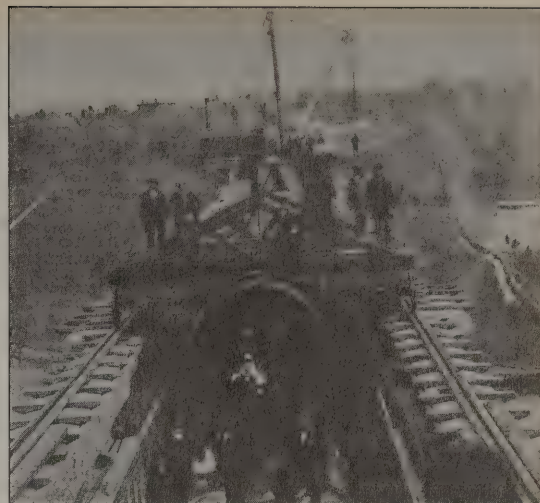
Soil is the key to clean water. Soil works as a physical strainer, a biochemical renovator, and a biological recycler of all wastewater passing through it. The story is as complex as a single cell or the biosphere itself. Besides a mix of grains of sand, silt, clay, and organic matter (humus), each teaspoon of rich soil contains a million to a billion bacteria, hundreds of thousands of protozoa, up to a hundred thousand or more algae, and up to millions of fungal strands (see box). The soil community eliminates pathogens, turbidity, and most color and taste problems in six ways: (1) it harbors creatures who out-compete the pathogens for food, as well as protozoa that prey on pathogens; (2) the soil, bacteria, and fungi produce antibiotics that poison pathogens (penicillin is produced by a soil mold); (3) the clay in the soil adsorbs viruses and other potential pollutants and the hydrophobic

(water-repelling) surfaces adsorb uncharged particles that could degrade drinking water supplies; (4) the soil's texture and structure act as a physical strainer; (5) the soil environment is so different from the host which

excreted the pathogen that the pathogens simply die from different moisture, temperature, acidity, and nutrient conditions; (6) the pathogens get trapped in the humus (the organic component of soil) where they eventually die from the extremes of wetness and dryness. Keep water in close contact with living soils as it flows from hill slopes to streams, and it is purified. The Croton has some 300 square miles of soil of varying depths and qualities.

### All or Nothing Rules

To date, federal regulations only address one question—to build or not to build a costly central-

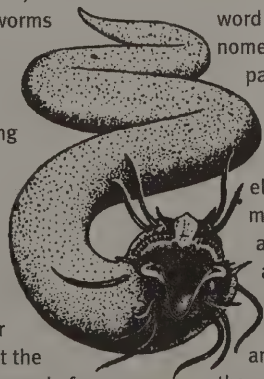


THE NEW YORK HISTORICAL SOCIETY

The 33-mile Croton aqueduct, opened in 1842, crosses the Harlem River, in foreground. The photo, circa 1890, shows the new tunnel for water (open pipe) and the older pipes (below). The Bronx (background) was rural.

Soil is a combination of "inert" grain particles with pore openings between the particles and many millions to billions of microscopic creatures who inhabit each cubic inch. Arrays of clay with sand and silt particles shape pore spaces into three-dimensional strainers that keep bacteria from moving into receiving waters. Hungry protozoa clean each bit of the strainer, consuming a million or more bacteria each day. Soil texture and structure also provide space for rootlets of plants and strands of fungi to intermingle, creating a "rhizosphere" or "root ecosystem" where truly biogeochemical wastewater treatment occurs. Roots, rootlets, and fungi, together with worms and beetles, also create large conduits which can increase the flow of surface runoff into the filtering soil and water table by ten- to a hundredfold.

The "inert" grain particles are the surfaces for attachment for stabilizing the flows through the soil. Clay particles, for instance, are so small that the total surface area in one pound of clay is the same as twenty-five acres of land surface.

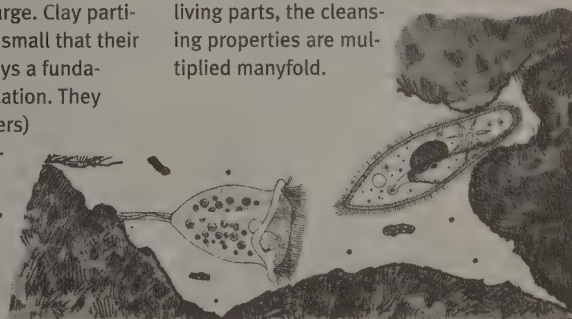
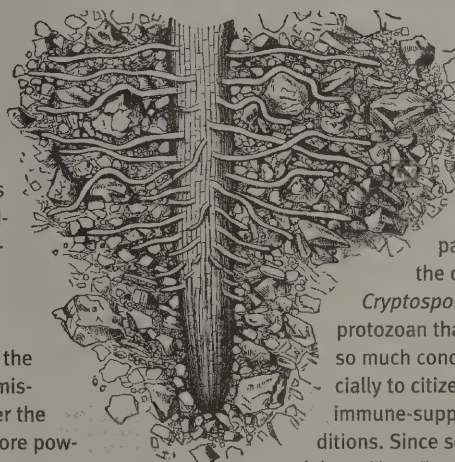


The microbial and rhizosphere community distributed in the soil profile can be seen as the ecological structure which fosters the purification process and slows the flow (in technical terms, increases hydroperiod) for the whole watershed.

And even then, the word "inert" is a misnomer. The smaller the particle, the more powerful its surface energy and electrochemical charge. Clay particles, for instance, are so small that their electrochemical charge plays a fundamental role in water purification. They are hydrophilic (water-lovers) and tend to: adsorb (electro-chemically hold) viruses, certain proteins, and specific bacteria so they can't move; react with nutrients like phosphates and nitrates; precipitate atoms

like Strontium 90 so they can't poison the water supply; and react with lime to change acidity. Uncharged particles, like peat moss parts, are hydrophobic (repel water) but tend to adsorb uncharged particles like the cysts of *Cryptosporidium*, the protozoan that is causing so much concern, especially to citizens with immune-suppressed conditions. Since soil is a mix of these "inert" particles and living parts, the cleansing properties are multiplied manifold.

Far left: Nematode: a protozoa predator. Below: A soil pore with protozoa and bacteria (rod-shaped).







A large water distribution tunnel being carved through rock 700 feet below Manhattan. In some places, city water tunnels such as this reach 2500 feet below the surface.

ized filtration facility. If built, an immense amount of financial capital goes into a single-purpose facility, subject to human error during operation, with inevitable moments of failure. In addition, the costs of capital and operation burden lower- and middle-class urban dwellers, and can even become a driving force in the flight to the suburbs. There is, further, the “out-of-sight, out-of-mind” aspect: With a filtration installation in place, the watershed’s citizenry loses its sense of responsibility for water quality. Increased covering of the soils with asphalt, malls, and condominiums on hill slopes further degrades rather than maintains or improves water quality.

The 1989 Surface Water Treatment Rules formalized the EPA’s approach to water quality. The rules require that all surface sources of drinking water be filtered unless municipalities establish that they meet all standards for water quality and “show control of the watershed.”

These rules are based on no rational criteria. They contain no measurable nor clearly stated standards for determining when surface water must be filtered. Although the EPA says they are in favor of multiple-use, multiple-barrier watershed protection and enhancement, the rules provide for none. No allowance or recognition is made for biogeochemical purification by the landscape. This is a virtual guarantee of contentiousness, since the rules lead to only one choice: to build or not to build.

The rules only allow filtration by an installation manufactured by the water filtration industry, with concomitant large inputs of energy and chemicals from outside the watershed. No equivalent investment and no stature has been given to natural sys-

tems. Besides the purification powers of soils, additional natural services provided by the watershed—humidification and scrubbing of the air, recreation, aesthetics, and protection from global warming—are also “outside the law” and the calculations of economic benefit.

“Control of the watershed” is not defined ecologically or even in terms of land use. The Croton is nearly twenty-five percent publicly owned, and the watershed is largely managed forest, but no distinction is made between a watershed which is ninety percent paved and one that is

ninety percent greenspace. Control is defined only by ownership. The rules thus equate private ownership with water quality degradation. Ownership, however, does not determine water quality. Biogeochemical activity and water-holding capacity do, regardless of ownership. In other words, it’s not who owns the land, but how it is managed. The EPA has left in its rules no role for stewardship.

This battle of rules, the watershed commons, and best management practices rages in a number of larger cities, especially Boston and New York. The expense for a filtration facility for the flow from New York’s Croton supply is \$1 billion, and \$10 billion for the complete system, which includes the Catskills and the Delaware inter-watershed transfers (see map page 56). Boston is looking at a two-hundred-million-dollar bill.

Where is the common ground? The Gaia Institute, the State Department of Health, and the EPA all agree that the health of water drinkers is paramount. Everybody also agrees that the Croton water quality already meets all of EPA’s criteria for drinking water. So why build anything? The EPA says the watershed is “stressed” and “shows cracks in the system.” But what does stress mean? How and what is stressed? Could the stressed parts of the watershed and infrastructure be dealt with at lower cost with more targeted projects? Could watershed managers practice “preventive medicine” to reduce the risk of drinking water falling below standards at some time in the future? In any case, the narrow focus on one, end-of-pipe techno-fix does not address the critical present and future issue: how to protect and enhance the watershed’s biogeochemi-



cal filtration effectiveness. Even with a filtration installation, a continually degrading watershed will only make matters worse and force an even more expensive water treatment process in the future.

Unencumbered by information to determine if the big filtration facility is necessary, the EPA has upped the ante by suing New York and filing an intent to sue Massachusetts for not complying with their filtration mandate.

### The Bigger Picture

The Surface Water Treatment Rule brings up some larger questions. Can the presence of humans be beneficial? Can sustainable development enhance economic well-being, the environment, and water quality in communities that live within their own or someone else's water supply? Can we drink the water we live with?

To live with the water we drink, two ecological principles must become incorporated in the rules and minds of the planners, designers, and funders of drinking water systems. They are: slow the flow and increase the intimacy between water and the filtration media of the watershed. Technically, this is

ment and treatment.

Hot spots along the thousands of miles of roadway and human-built hard surfaces in the Croton watershed must be located and mapped. Sources of runoff carrying the wastes of vehicle exhaust, pets, pigeons, and septage need to be identified. From this map and assessment, the best management of biogeochemical purification by the soil and increased hydroperiod can be determined. Comparative costs of enhancing ecological structures are likely to be a fraction of the annual interest on the billion dollars required for centralized technological filtration.

By monitoring the watershed, it may become possible to continually improve the benefits of wetland, upland soil and in-stream water purification. Predicting precise costs is difficult because each monitoring station would be custom designed to fit landscape and water quality conditions, but information on water quality would make it possible to evaluate the pollution source, its risk to human health and water quality, and potential costs of available management practices to solve the problem, i.e., a risk based, cost-benefit approach to improving water quality.

Sustainable development continues to generate discussions in agencies around the country, but not much has been accomplished on municipal, state and federal levels to achieve sustainable goals. But now, the defining criterion is at hand: development is sustainable when it protects and enhances water quality in the watersheds where we live and work. ⊕

Paul S. Mankiewicz, executive director of the Gaia Institute, is trained in physical chemistry, developmental biology, and ecological engineering. He specializes in the interface of plants, soils, water, and atmosphere.

### Gaia Institute

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718/885-1906, fax 718/885-0882,  
gaiainst@aol.com (preferred).

The purpose of the **Gaia Institute** is to test and demonstrate ways that the ecological components of human infrastructure, as well as watersheds and estuaries, can be enhanced through integrated waste-into-resource technologies. Projects include designing and monitoring test systems for biogeochemically purifying stormwater in Queens, utilizing salt- and fresh-water wetlands to mitigate pollution in Pelham Bay, and serving as scientific consultants on the restoration of landscapes and water bodies throughout the region.

land, upland soil and in-stream water purification. Predicting precise costs is difficult because each monitoring station would be custom designed to fit landscape and water quality conditions, but information on water quality would make it possible to evaluate the pollution source, its risk to human health and water quality, and potential costs of avail-

A central-city distribution reservoir (1893) at Fifth Avenue and 42nd Street in Manhattan, the site now occupied by the New York Public Library.

described as increasing the hydroperiod and filter contact time. To live with and drink the water in the Croton watershed, the amount of runoff that infiltrates the soil and enters the groundwater can be maximized. The Gaia Institute has suggested this as a workable strategy since 1989. Right now it is ignored.

Landscape-based treatment installations which can be replicated throughout the watershed will provide decentralized, redundant, robust, and lower-cost water quality protection and enhancement with increased health protection. They should also yield higher water quality. This tool kit includes: terraces, gabions, coupling wetlands with upland soils, stream bank stabilization, in-stream aeration, and infiltration hollows and basins. Since the first rains after a period of dryness wash over eighty percent of surface pollutants into receiving waters, the new approach would be designed for "first flush" catch-

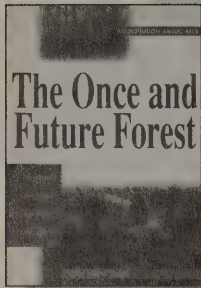
Julie A. Mankiewicz, director of research and education at the Gaia Institute, teaches environmental studies at Queens College Worker Education Extension Center, City University of New York. She specializes in biochemical stormwater treatment and the restoration of uplands and wetlands.





## The Once and Future Forest A Guide to Forest Restoration Strategies

Leslie Jones Sauer and Andropogon Associates. 1998; 381 pp. \$30. Island Press.



Andropogon Associates has pioneered a working partnership that brings the education and participation of communities into active watershed restoration. They are great at combining local knowledge (citizen science) with science-based knowledge. Their specialty is rehabilitating and restoring more humanized landscapes, including Central Park in New York City and Prospect Park in Brooklyn.

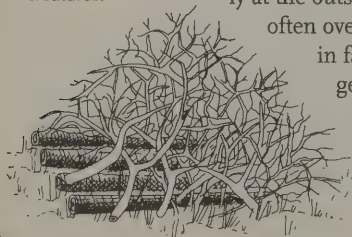
This is the only book on metro-forests, and one not likely to be surpassed. It is the most comprehensive and intimate book on the restoration of New England's forests, woodlands, and wetlands. From hand tools to land use mapping, it is a Whole Earth best. —PW

“ One of the most basic and interesting questions to ask about any landscape is “What is reproducing here?” In a very real way, this inquiry acts as a window into the future of the place and a key to sustaining or enhancing its biodiversity.

“ For many people, simply being able to leave the beaten path is at the heart of their sense of contact with nature. It seems so harmless, and we all do it, from the birdwatcher to the dog walker, but the impacts are severe and often underestimated....All too often, not providing enough amenities to users leads to off-trail use....To keep delicate relic landscapes out of harm's way, the restorationist must carefully evaluate and justify each footstep, and plan trails to take visitors where they want to go.

“ The primary obstacle to the use of native grasslands and meadows is the lack of simple, effective establishment and maintenance methods. There are two major problems. First, the Northeast has no local, large-scale seed production nurseries; and second, in most instances regulatory agencies do not require or recommend native species....Because native grasses...typically develop slowly at the outset, agencies have often overlooked them in favor of faster germinating, early season exotics.

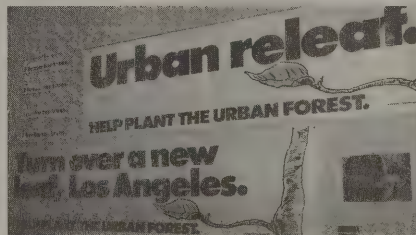
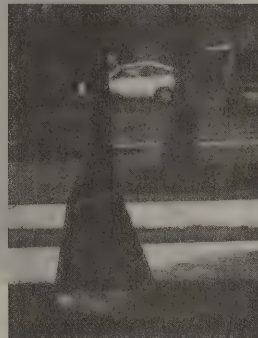
A brush pile oriented to receive some direct sunlight provides shelter for small creatures.



## The TREGATOR Irrigation System

\$22, 1-10 bags; a little less for more. Ben Meadows Company, 3589 Broad Street, Atlanta, GA 30341, 800/241-6401, fax 800/628-2068, www.benmeadows.com.

A new portable drip irrigation system. Each bag holds twenty gallons of water and provides up to sixteen hours of drip time with no runoff (drip rate is adjustable). Your time standing there watering or letting water spread all over the place is reduced by eighty percent or more. The amount of water used is probably about half, depending on root depth. It's best for transplants—one bag is good for a tree up to three inches in diameter; use two bags for trees of four to twelve inches in diameter. The bags join together with rust-proof zippers. —PW



## The Simple Act of Planting a Tree Healing Your Neighborhood, Your City, and Your World

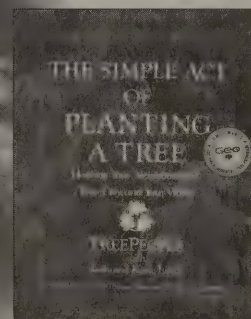
TreePeople with Andy and Katie Lipkis. 1990; 237 pp. \$12.95. TreePeople, 12601 Mulholland Drive, Beverly Hills, CA 90210, 818/753-4600, fax 818/753-4625, www.treepeople.org.

I once helped TreePeople in a series of LA workshops. I observed two chemistries—outside the window, smog and cars; inside, the chemistry of older Earth guardians chatting with exceptional high school kids. I heard insights and curiosity and desires as they envisioned a rich urban forest. I remembered a sixties billboard: No reforestation without de-light.

From this heart of the most urbanized landscape in North America, from Los Angeles, comes a friendly, chatty, informative guide for how to set roots in the concrete jungle. How to choose the right tree. How to rally the condo owners or local businessmen or drug-rehabilitating youth. How to find money for the project. How to care for the planted tree. For over twenty years, TreePeople has combined the pizzazz of Beverly Hills with the beauty of urban forestry. There's no better access to tools and practice. —PW

“ Of course, you can plant and care for trees without any hoopla at all. But remember, this book is about nurturing community. A magic develops when people work together and tell the world they're working together. To pull off a successful event requires enormous effort, but it's worth every bead of sweat. There's no high like an event high.

“ It's best to maintain an area of at least two feet in diameter free of turf and weeds around the base of tree trunks.... After four or five years, tree roots are extensive enough that other plants close to their trunks are not as much of a problem, although mower operators should still exercise caution. One energy-saving way to control weeds is to apply a thick layer of mulch.





# Humane CONSTRUCTURE

CAN  
INDUSTRY  
BECOME  
GAIA'S  
FRIEND?

**Hardin Tibbs**

**Q**uick, define "industrial ecology." Does it mean "linking manufacturing facilities together like an ecosystem to reduce or eliminate waste"? Well, yes and no. This definition is accurate up to a point, but there is more to industrial ecology than this.

Industrial ecology is the need to place the whole global-industrial system in the context of planetary physiology. Its ultimate aim is to create a planetary order of technology for the long haul—a planet-wide deployment of technology suited to the special characteristics of Earth. Put another way, this means the emergence of a technological infrastructure that can harmonize with the Earth's unique biogeochemical processes and cycles. One of the main reasons for thinking on such a large scale is that industry itself has now reached planetary scale—its throughputs and waste flows are so large that they are disturbing the large-scale planetary life-support systems on which we all depend.

Industrial ecology focuses not only on the structure of industry, but also on the systems and structures of planetary physiology. The appropriate long-term structure of industry cannot be determined until we have a good understanding of the way the planet works, at both large and small scales, both in time and space. Since the whole concept of looking at the physiology of the Earth itself is relatively new, industrial ecology has important


contributions to make in this area, focusing study on the insights needed for the design of industry.

The British scientist James Lovelock coined the term Gaia (the name of the ancient Greek goddess of the Earth) to express the idea of the entire planet as a single living superorganism, complete with its own physiology, as complex as any regular organism. Lovelock pioneered the study of planetary physiology, or geophysiology as he calls it. As we begin to uncover the intricately interlocked workings of geophysiology, the implications for industry become clear. We contain within our bodies biochemical processes that not only serve our own life, but also enable the biogeochemical processes of Gaia. In a very literal sense, we are a functional part of the planet. Industry needs to be structured the same way—to serve human needs as well as planetary needs. Industry must become a cooperative part of the planet, of the life of Gaia.

## GEOPHYSIOLOGY AND INDUSTRY

Needless to say, industry is far from that today. So how do we make a bridge between geophysiology and the design of industry? The keys to geophysiology are to understand the cycles of matter, the way feedback loops regulate the cycles, the key stocks and flows in the system, and the way living and non-living elements in the entire system interact. We can study how industry works on the large scale





by mapping it in much the same way. The study of industrial metabolism, pioneered by scientist Robert Ayres, is a natural complement to geophysiology—indeed, given the scale on which we are doing things, it is rapidly making a significant impact on it. Industrial metabolism involves looking at the way elements flow from the environment into and through industry, and back out into the environment. The elements or molecules of most interest are those that flow in the greatest volume, and those that are the most toxic—either to organisms or to Gaia—carbon, sulfur, nitrogen, heavy metals such as cadmium and mercury, CFCs, etc.

Once we have understood better how Gaia works, and once we have a good grasp of today's industrial metabolism, we will be in a position to devise a new form of industry. At that point, we may find we have to redefine the concept of industry itself. This is why the idea of industrial ecosystems, and eco-industrial parks like the one at Kalundborg in Denmark, although vital, are not enough on their own. The heart of the industrial ecosystem at Kalundborg is a large—1500 megawatt—coal-burning electricity generating station called Asnaes. While it is true that many valuable savings in the use of materials and water have been achieved by linking Asnaes to other industrial facilities in the surrounding area, it seems unlikely that burning coal for energy production can be acceptable for very much longer.

In the larger context of materials, open combustion of hydrocarbon fuels, at least on the huge scale that we do it today, is not sustainable. Already the carbon released by human activity, 7.5 billion metric tons a year, or about a sixth of the natural annual exchange with the atmosphere from terrestrial plants and animals, is perturbing the global carbon cycle, with possibly serious effects on climate. In the long run we will have to choose industrial materials and processes that not only interlock with each other, but also with geophysiology. In principle, we could engineer the whole of industry so that there were no flows at all into the environment (this has been referred to as a Type III industrial ecosystem). In practice, not only will there inevitably be leaks, but some processes are intrinsically open—for instance agriculture and the production of biomass feedstocks, and many end-uses of materials.

When an industrial ecosystem is created to reduce materials use and waste, what happens if or when one of its component processes becomes obsolete? Does the whole industrial ecosystem then become unviable? Or can structures of interlock be designed which allow for change—such as cleaner future technology—without creating increased

**Industrial Ecology is a field of knowledge and endeavor that aims at ensuring that human ecostructure can meet the needs of all peoples and exist in harmony indefinitely with the natural biogeochemical systems of this planet.**

dependence on such things as coal-fired power plants? Put differently, can interlock be achieved without unwanted lock-in?

### Interlock, Not Lock-In

The answer is likely to depend on working through a sequence of steps. One approach would be first to identify a set of materials which have long-term geophysiological compatibility. A fairly small set of acceptable materials could probably be used to supply eighty percent or more of all production needs. The next step would be to devise clusters of production processes

which use some or all these materials, and which can be interlocked ecosystem-style. Once this was done, the resulting industrial clusters or industrial ecosystems might stand a reasonable chance of being stable over time. Gunter Pauli of the Zero Emissions Research Initiative (ZERI) at the United Nations University in Japan, has shown that focused industrial clusters of this sort, based on biomass inputs and zero waste, can make very good business, social, and environmental sense.

### VOLUMES

If closed loops of materials flows are established, the next question is whether the volume of materials flowing in the loops can be allowed to grow or not. Linear throughput growth (in which materials flow through the economy as if through a straight pipe) places a double burden on the environment—once during the production of virgin materials, and again when wastes are ultimately dumped—and about ninety-five percent of all the materials we use end up as waste before the finished product is even purchased. But if all materials flow in a loop, does the volume in the loop matter? At first sight, it would appear not, but on closer examination, it is an issue.

First, as global population and relative affluence increase, the demand for materials is growing exponentially. In the United States alone, total materials use has ballooned from 140 million metric tons a year in 1900 to 2.8 billion metric tons a year in 1990, up from about 1.6 tons a person to 10.6 tons a person. If all materials flowed in a closed loop, more and more virgin materials would need to be poured into the loop to meet this growing demand. Suppose this growth was offset by dramatic dematerialization of the useful products created, to the point where the volume of materials in the loop could at least be kept stable. Would this be enough? The answer depends on the level of leaks from the loop, and the characteristics of the energy used to keep materials moving round the loop. Even in a loop, materials need to be transported and processed repeatedly to keep them useful, and this requires energy. If energy produc-



tion still has a high environmental cost—for example because it still results in high carbon dioxide emissions—then the volume of materials in the loop would have to be reduced over time to lower the energy consumption. Once again, simply folding linear flows into webs and loops is not enough.

### MORE THAN TOOLS

Another misleading, partial definition is to think in terms of industrial ecology as simply a combination of best practice environmental management tools, such as life cycle analysis (LCA) and design for environment (DFE). This fails to grasp the larger intent of industrial ecology. It is not just another tool, nor is it even another environmental management system (EMS). Industrial ecology is—or at least aspires to be—the emerging field of knowledge that inter-relates the various environmental tools and management systems that have been devised so far. It generates an overall context and gives the whole set of tools and systems a coherent objective—aligning industry with geophysiology.

The trouble with the word “industry” is the image it typically evokes of gloomy gray buildings with saw-tooth roofs and tall stacks belching grimy smoke. We need a different conception of industry. In ecology, the term “ecostructure” refers to the pattern of physical structures created in ecosystems by the organisms that comprise them (and to the physical structures ecosystems occupy). Simple examples would be spider webs in a meadow, termite nests arrayed in a savanna, and beavers’ dams in a watershed. Humans create ecostructure, too—lots of it, ranging from landscape patterns of buildings, roads, and bridges, to vast dams, water and sewerage systems, and energy supply grids, not to mention all the productive infrastructure of industry. Just as a dam built by beavers both serves the purposes of the beaver and plays a role in the hydrology of the landscape, so all the structures and systems we create should have a benign dual role too. This means applying the logic of industrial ecology to the design of human ecostructure in general, and learning to think of it as a single system, an interlinked design endeavor.

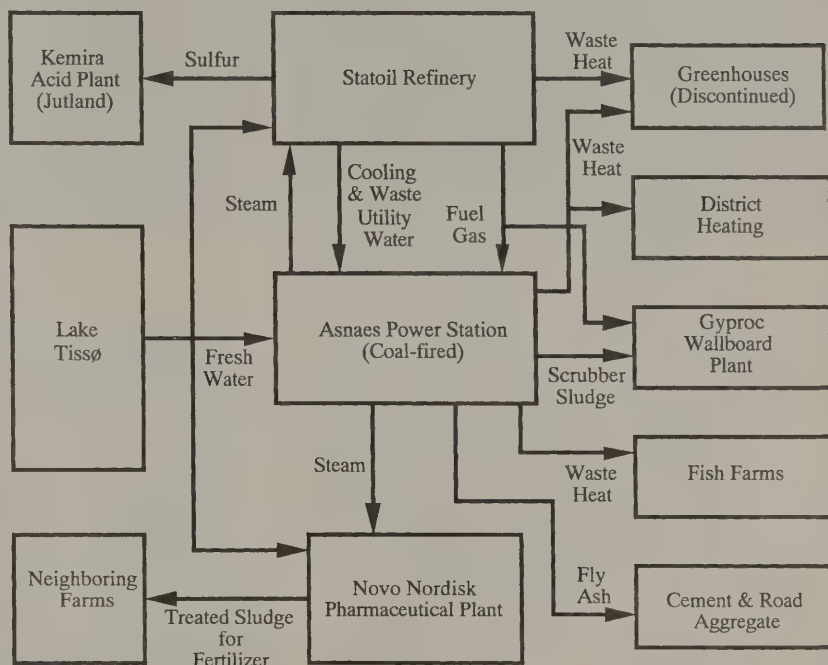
### INDUSTRIAL ECOLOGY: THE NEW PHASE

In the broadest sense, industry and human ecostructure equate with our total use of technology around the world to serve society and individuals. If we factor into this the need to work within geophysiology on both the large and small scales, the need to do this equitably, and the ability to keep doing it over time, a more comprehensive definition of industrial ecology emerges. It might read something like this: “Industrial Ecology is a field of knowledge and endeavor that aims at ensuring that human ecostructure can meet the needs of all peoples and exist in harmony indefinitely with the natural

biogeochemical systems of this planet.”

It is important to stress that this refers not only to the physical components of the system. In systems terminology, structure implies more than physical features, it includes the pattern of relationships in the system, the way the set of stocks, flows, loops, and delays are connected together. The relationships between beavers, their dams, and the landscape are to a large extent programmed in their genes. Similarly, we need to embed appropriate conceptual structures for human ecostructure design into organizational planning and strategy, and government policy.

As it happens, the ecosystems metaphor is already becoming influential in corporate strategic



planning. Strategists are increasingly talking about “business ecosystems,” about “value webs” rather than value chains, and about “co-opetition,” a balance between competition and cooperation as is found in nature. This amounts to a realization that business is more successful when it adopts a “live and let live” orientation rather than when it attempts to destroy all competition, and that the “survival of the fittest” is best understood in terms of the “survival of those that fit best.” This shift of outlook is an ideal grounding for the next step, which is to relate business strategy and survival not only to adaptive fit with other businesses, but also to adaptive fit with the natural environment. If strategic ideas and industrial ecology flow together—a convergence whose time may be just about to arrive—it could well open the way for industry, and indeed all human ecostructure, to become truly sustainable. ⊕

Hardin Tibbs’s original paper on industrial ecology appeared in WER No. 77, (it can also be downloaded from the web at [www.sustainable.doe.gov/articles/indecol.htm](http://www.sustainable.doe.gov/articles/indecol.htm)). Hardin is an associate of the Global Business Network

The industrial ecosystem at Kalundberg, Denmark. —JOURNAL OF INDUSTRIAL ECOLOGY (see review, p. 64).

This view is incomplete; it does not include the influence of coal-burning on the atmosphere.

(GBN) in Emeryville, CA, and is also Managing Director of Ecostructure, an international consulting firm based in Canberra, Australia, specializing in strategy for sustainability. He can be contacted at [htibbs@ecostructure.com.au](mailto:htibbs@ecostructure.com.au).





## Books and Articles about Industrial Ecology

### For A Sense of the Field

#### Industrial Ecology

Thomas Graedel and Braden Allenby. 1995; 412 pp. \$50. Prentice Hall.

This comprehensive textbook is an excellent place to start, and a basic resource for making sense of industrial ecology. It presents all the major concepts and tools and relates them together at both the big picture and small picture levels.

#### Industrial Ecology

(A Historical View). Suren Erkman. www.smu.ntnu.no/PROG/STIE/LectureSlides/Erkman/.

If you are curious to know where industrial ecology came from, and who first

trial system just like carbon and nitrogen cycle through nature is one of the crucial insights needed for understanding industrial ecology. Bob Ayres is the inventor and pioneer researcher of industrial metabolism, the science of studying and tracking these flows. The style of this book is somewhat terse, but it presents indispensable information on the flows of key environmentally important materials.

The authors highlight the difficulty of getting reliable quantitative data for this kind of analysis. Here is a valid role for government: to mandate complete collection of statistics on the production of minerals, metals, and chemicals.

### Discovering Industrial Ecology

(An Executive Briefing and Sourcebook on Industrial Ecology). Ernest Lowe, John Warren, and Stephen Moran. 1997; 202 pp. \$19.95 (\$23.45 postpaid). Battelle Press, 505 King Avenue, Columbus, OH 43201, 800/451-3542, fax 614/424-3819.

This guide to industrial ecology for policymakers is a collage of insights and examples which achieves its aim of making industrial ecology accessible to non-engineers.

### More Specialized

#### Industrial Ecology and Global Change

Robert Socolow, Clinton Andrews, Frans Berkhout, and Valerie Thomas, eds. 1994; 500 pp. \$35.95. Cambridge University Press.

This is the record of an intensive two-week meeting

tion and innovation in fact toward a lessening of pressures on the environment? The overall tone is upbeat; nevertheless it is an important exploration of links between technological trajectories, human development and environmental impact.

### Of Historical Interest

#### Technology and Environment

Jesse Ausubel and Hedy Sladovich. 1989; 221 pp. \$25.95 (\$29.95 postpaid). National Academy Press (see access above).

This book, based on a symposium chaired by Bob Frosch in Washington in 1988, prepared the way for the adoption of industrial ecology in the 1990s. If you want to see some of the seminal technical arguments that lie behind industrial ecology, this is the place to look.

#### Managing Planet Earth

(Readings from Scientific American magazine). 1989; 146 pp. \$16.95. W.H. Freeman.

A seminal special edition of *Scientific American*, that contains the article by Robert Frosch and Nicholas Gallopoulos, "Strategies for Manufacturing," which jump-started widespread interest in industrial ecology.

### For More Depth

#### Designing Interactive Strategy

(From Value Chain to Value Constellation). Richard Norman and Rafael Ramirez. 1994; 155 pp. \$88.50. John Wiley.

Michael Porter at Harvard introduced the concept of the value chain as a useful way of understanding the sequential value-adding functions of a business. This book proposes the value constellation, an analogy of the food web (although the authors don't identify it as such), as a better way of understanding how value is now created through strategic interactions between firms and their customers and suppliers. It is a short step from this to thinking in terms of business ecosystems.

### Co-opetition

Barry Nalebuff and Adam Brandenburger. 1996; 288 pp. \$15.95. Doubleday.

Is destroying the competition the best strategy? If you think so, read this book. Game theory has been around for some time, but this is the first time it has been made accessible to corporate strategists—or indeed to anyone wanting to understand how games should be played and won. Systemic solutions such as industrial ecology are going to depend on strategic thinking of this kind.

### Hierarchy Theory

(A Vision, Vocabulary, and Epistemology.) Valerie Ahl and T.F.H. Allen. 1996; 206 pp. \$19.50. Columbia University Press.

Emergence and surprise happen in systems when new hierarchical levels emerge, and hierarchy theory navigates these levels by focusing on the links between observation, perception, and learning.

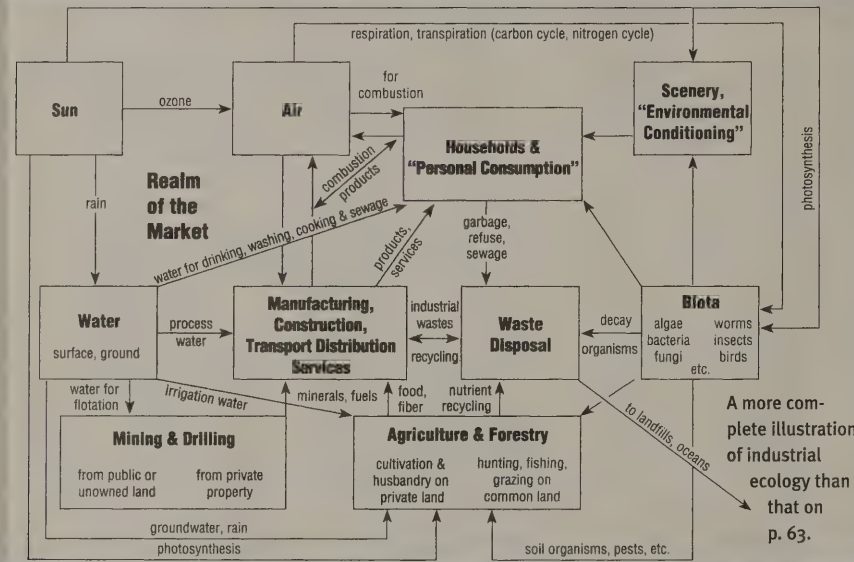
If you are already up to speed with the basic elements of systems thinking, here is a complementary set of conceptual tools to add to your repertoire.

### For Fun

#### Rendezvous with Rama; Rama II; The Garden of Rama; Rama Revealed

Arthur C. Clark and Gentry Lee. 1975-1993. All \$6.99. Bantam Spectra.

This four-book story from the man who invented geostationary satellites and his NASA scientist co-writer is classic science fiction with an industrial ecology spin. The artificial ecology inside the vast, empty alien spacecraft *Rama* provides a mechanistic metaphor for the organic one we refuse to take seriously on Earth. And it sets the stage for an allegory of the way we act, faced with dependence on such a marvel.

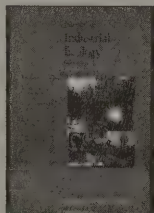


used the term, this is where to look. Suren Erkman is a Swiss science journalist who became fascinated by IE and has spent several years researching its roots.

#### Industrial Ecology

(Towards Closing the Materials Cycle). Robert Ayres and Leslie Ayres. 1996; 379 pp. \$95. Edward Elgar Publishing Inc., 2 Winter Sport Lane, PO Box 574, Williston, VT 05495-0080, 800/390-3149 fax 802/864-7626, rhenning@e-elgar.com.

The fact that individual elements cycle through the indus-



### Practical

#### The Journal of Industrial Ecology

Reid Lifset, ed. \$40/yr (quarterly). MIT Press Journals, 5 Cambridge Center, Cambridge, MA 02142. 617/253-2889, fax 617/577-1545, http://mitpress.mit.edu/JIE.

This is a peer-reviewed journal devoted to industrial ecology. It contains the latest thinking, research, and industrial-case examples at the growing tip of industrial ecology.

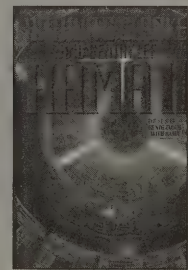
convened in 1992 by the Global Change Institute on Industrial Ecology and Global Change. Papers include a good diversity of authors—international research is represented, including authors from less industrialized countries.

#### Technological Trajectories and the Human Environment

Jesse H. Ausubel and H. Dale Langford. 1997; 224 pp. \$42.95. National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20055, 800/624-6242, www.nap.edu. 20% discount for orders from website.

An important set of technical essays which asks: Is the direction and pace of inven-

THE GREENING OF INDUSTRIAL ECOSYSTEMS

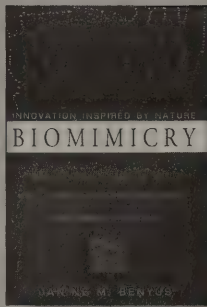




## Biomimicry Innovation Inspired by Nature

Janine M. Benyus, 1997; 398 pp. \$13. William Morrow and Company.

One of the necessary strategies for humans to live "sustainably" is to design as nature does. Naw, this isn't a call for Boeing's next airliner to flap its 150-foot wings like a big bird, or yet another cheer for (edible) strawbale buildings. It has to do with understanding nature's efficient use of resource and energy; how to harvest and utilize in harmony with the ecosystems that enable us to live. The author, a careful observer of wildlife, calls the concept "biomimicry." Lots of examples and an energetic writing style make it downright fascinating. —J. Baldwin



## Greening the North A Post-Industrial Blueprint for Ecology and Equity

Wolfgang Sachs, Reinhard Loske, Manfred Linz *et al.* 1998; 247 pp. \$25. Zed Books Ltd. Distributed by St. Martin's Press.

There is no equivalent of the Wuppertal Institute in the United States, a think tank

“The idea of large-scale material infrastructure as the precondition and motor for economic development derives from the period of early industrialization. Adam Smith recognized that the “Wealth of Nations” could only be achieved if specific public tasks—such as the construction of roads, canals, and harbours—were part of the state’s productive responsibility....

Today it would be fatal to base activity on the models provided by early industrialization....

Future infrastructure will be based on declining demand for energy, raw materials, and land in an “economy of avoidance.” Infrastructure can provide incentives for reducing consumption of nature.

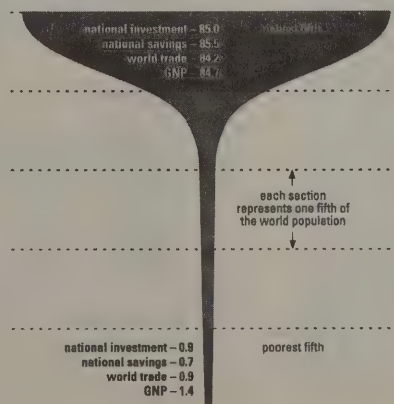
“In 1991 Munich’s public utilities decided to support conversion to organic farming in areas supplying drinking water....Contracts were concluded between

“In ensemble, living things maintain a dynamic stability, like dancers in an arabesque, continually juggling resources without waste. After decades of faithful study, ecologists have begun to fathom hidden likenesses among many interwoven systems. From their notebooks, we can begin to divine a canon of nature’s laws, strategies, and principles that resonates in every chapter of this book: Nature runs on sunlight. Nature uses only the energy it needs. Nature fits form to function. Nature recycles everything. Nature rewards cooperation. Nature banks on diversity. Nature demands local expertise. Nature curbs excesses from within. Nature taps the power of limits.

“Once upon a time, before there were nutritionists or USDA safety inspectors, our primate ancestors knew how to put together a sensible, safe diet. Somehow, they’d learned to shop the supermarket of the plains, jungles, and

of activist visionaries pointing out the indicators and goals for regional sustainability. Their region is northern Europe, and Wuppertal has become a kind of shadow government, doing the research and stating the policies that often governments give lip service to (and not much more). In no way naïve, **Greening the North** clearly portrays the global dilemmas; points to where consumption and pollution come from, and directs the North to clean up its act rather than become a role model of hypocrisy for the South. It’s the first book of its kind; time to imitate and learn. —PW

the Munich authorities and every individual farm. Conditions regulating farming (including complete renunciation of synthetic mineral fertilizers and pesticides) had to be laid down so as to protect drinking water. For such water-saving ecological use of the land, farmers are paid 550 DM per hectare annually for a total of six years.



seas, avoiding the dangers while cashing in on digestible nuggets of nutrition. In a country where millions are spent each year on diet and nutrition advice, why haven't we consulted the mammals, birds, and insects that successfully act as their own nutritionists? Might their choices show us what we may have been meant to eat, in a purely biological sense?



## The Natural Step

PO Box 29372, San Francisco, CA 94129-0372, 415/561-3344, fax 415/561-3345, tns@naturalstep.org, www.emis.com/tns.

The leading educational and training organization for persons of power and persons of money, **TNS** attempts to teach a common language for reconciling economic and environmental concerns. At **Natural Step** seminars, environmental awareness can seep into a company and even into green management and employee lifestyles. **TNS** is where top-down leaders can learn how infrastructure and ecostructure can begin to work together. Never underestimate the power of education to change transnational governance nor the ability of **The Natural Step** to re-orient the existing industrialized atrophy of mind and planet. —PW

## “System Conditions

1. Substances from the earth’s crust must not systematically increase in nature [e.g., don’t promote a build-up of greenhouse gases from petroleum].

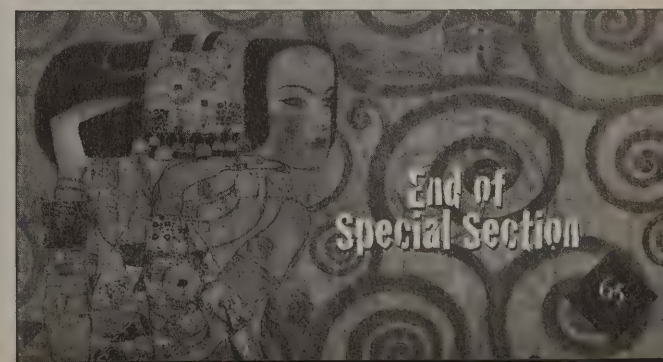
2. Substances produced by society must not systematically increase in nature [e.g., don’t make products with persistent organo-chlorides like PCB].

3. The physical basis for the productivity and diversity of nature must not be systematically diminished [e.g., don’t harvest fish stocks faster than they can be replenished; don’t destroy habitat of rare species].

4. We must be fair and efficient in meeting basic human needs.

—THE NATURAL STEP NEWSLETTER

World distribution of economic activity, 1991 (% of global total).





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*"I went to the woods  
because I wished to live  
deliberately, to front  
only the essential facts  
of life, and see if I  
could not learn what  
it had to teach."*

*-Henry David Thoreau*

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**"...he is one of the planet's most erudite and far-seeing advocates of a transformed relationship with nature." — Utne Reader, 1995**

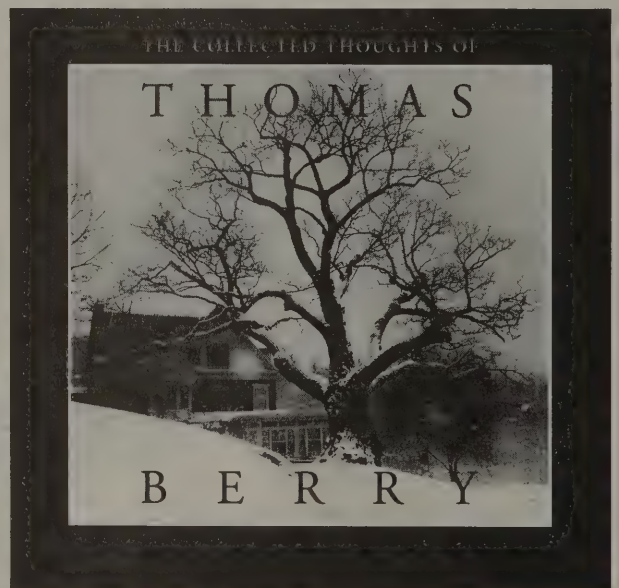
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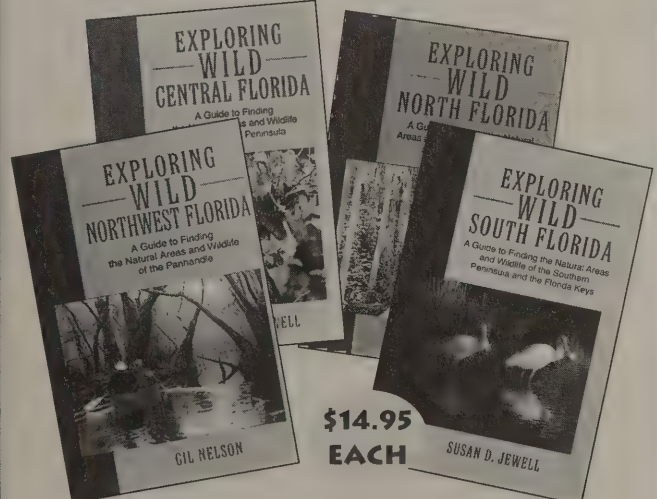


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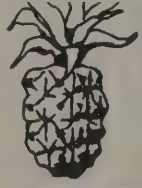
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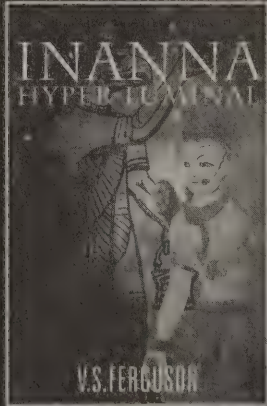
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# Just a Little Too Well Behaved

## A 1997 Bioneers Speech on ZERO DISCHARGE

by Diane Wilson

Hi there. I'm a commercial fisher from the Texas Gulf Coast. I might say that I've spent over forty years on the Texas Gulf Coast. I've fished the bays. I've been in the rivers. I have set out on the Gulf of Mexico and watched those bays and those rivers systematically go down. In Texas and Louisiana, that's one proud thing we get to fight over: who's the most toxic state in the nation. Every once in a while Louisiana gets it and every once in a while Texas gets it. All the petrochemical plants, they come down on the coastline and they use the tax abatements and they use the cheap labor and they use all the political corruption going on down there, and they use those bays for transportation and as a place to dump their waste.

A few years back I learned a very valuable lesson. I learned it when I had a chance to go to Taiwan to fight one of my foremost opponents

down on the Gulf Coast, Formosa Plastics, which is a \$2 billion petrochemical polyvinyl chloride plant. My work had been covered by the underground Chinese press, and the Taiwan Environmental Union, an illegal group, was holding demonstrations, trying to throw out Chairman Wong and the Formosa plant. Legislator Chen invited me, sort of sponsored me, to come and talk to grassroots groups, unions, and so on for two weeks. I learned of people being jailed, disappearing, being tortured and killed. That trip, those people, radicalized me. I felt like the people in the US didn't know how to make change. That lesson is best expressed by a quote from Henry David Thoreau. On his deathbed he is quoted as saying the only thing he regretted was that he was too well behaved.

You might ask what that has to do about bio-remediation, or about restoring the Earth. I'm telling you: I've been working on zero discharge of petrochemical plants on the Texas Gulf Coast, but the point of it is, zero discharge law has been around for twenty years. It was in the Clean Water Act. It's a federal law and it hasn't happened yet, and the reason why is because us folks out here are just a little too well behaved about asking for it and demanding it. My whole point here is not only to talk about zero discharge, but that you can do it and that anybody can do it; because if a fisherwoman with a high school education that doesn't even like chemistry can get compliance from a petrochemical plant, then anybody out there can get zero discharge from any type of facility they care to get invested in.

I guess most of you folks know about that Toxic Release Inventory (TRI) Data, where for the first time, about ten years ago, industry had to report how much toxins they were putting out. My county on the Texas Gulf Coast is probably about the smallest one there is out there. The whole county's got about 15,000 people. There's a lot of fishing, a lot of petrochemical plants. Anyway, we're not known for absolutely nothing. Houston's too far away. Galveston's got a prettier beach. Corpus Christi's prettier than we are. The reason why anything got started was I read in an Associated Press story that my county—they mentioned our county three times—we were the number one county in the nation for toxic disposal. That just kind of blew my mind, if you'll pardon the expression there. I could not even conceive it. I knew there were chemical plants all the way around there, but I never knew the amount of what was going in there.

At home, I usually  
 Sometimes I  
 Relax in the garden  
 Just stop them back  
 to the more chaotic  
 world  
 Sometimes I don't  
 home with intimacy  
 with gossip, a wall  
 of glass

TEXAS OBSERVER



## SENATORS IN THE FISH HOUSE

I'm actually a very mild, quiet-type person. Believe it or not, I took speech for ten years when I was a kid, and I hid under the bed anytime anybody would come into the house—I was that quiet of a person. But on that TRI information, I just formed an environmental group. All I did was call a meeting in my town and I ended up with bank presidents, chambers of commerce. I had senators down there in the fish house. And I had people calling me a terrorist. They were certain, certain, absolutely certain, that I was a spy for the state of Louisiana, because what they were trying to do was bring down that \$2 billion chemical plant out of Taiwan. And the reason why was because it had gotten kicked out of Taiwan, and they were coming down to the state of Texas.

So Chairman Wong was just going back and forth between Louisiana and Texas and seeing which one was going to give him the most money for coming down and polluting their bays and waters. Texas got the prize because we gave him \$200 million. And we gave him the little ship channels and we gave him the banquets. And for that reason, because I protested their expansion, I was considered a spy. I was considered a terrorist. I remember at one time Formosa even threatened to sue me, and I had every single one of my board members quit because they were afraid that they were fixing to get sued.

People would come up to me very quietly and tell me they couldn't get involved because they had to have bank loans, they had to have some of their kinfolk working at some of the plants. Because when the fishing industry goes down, you have a hard time. And these are poor people, so sometimes during the winter, when it really gets rough, they have to get jobs at these petrochemical plants. And so what happened was—I'll bring in a little quote by Gandhi (I'm real big about bringing out quotes): it's a myth to believe that you need a lot of people and that you need a lot of money because you don't. All you got to do is have your commitment and your belief and all it needs to do is start with you. All it takes is one person. So what I did, was I absolutely drew a line in the sand and I said they were not going to take those bays any longer. I had set there and watched the dolphins die off. We had one of the



BILL CURTSINGER

largest dolphin die-offs ever recorded in the Mammal Stranding Network's history. All the dolphins, all the alligators—they were just sitting, rolling in the water. And you would go out there and you would find just hundreds of dead dolphins. I remember one of the most tragic pictures I ever—it was acres, acres of land with the dead dolphins

coming out of our bays laying stretched out there.

We set there and watched the red tides, the brown tides, the green tides. We set there and watched Alcoa Aluminum, with a permit from an agency, create a mercury Superfund. Now you've got mercury in the sediment, you got mercury in the fish. And what do the shrimpers do? They sit on top of the Superfund out in the bay, and they take the shrimp up,

and you folks out here are getting nice, mercury-laden shrimp. This is what is going on.

## YOU CAN SAVE THE WATER

But the point is, twenty years ago we could have done zero discharge, except nobody's asking for it. I remember one time I spoke before a Gulf of Mexico symposium and I was before industry and I was talking zero discharge, and these CEOs in the background were saying, "What are we talking here? Philosophy?" Zero discharge is a philosophy? No, it's not a philosophy, it's a technique. It can be done. There is a lot of technology around. It has been done a long time. For instance in the Arab countries they've been doing it, not because they were so worried about the pollution and they were real conservation minded, but because they had to have the water. They couldn't waste their water. A lot of the zero discharge technology arose from this desire to keep the water in a closed loop. And that's one of the real benefits of it. You not only can close the loop on pollution and discharges going into the water, but you can save water.

Like in the agreement I finally got with Formosa—and like I said, it took being outrageous, because in the beginning nobody believed me; they thought I was a real nut. Now they just think I'm a real persistent nut. But that's what it takes. When I first started talking zero discharge with these companies—and these companies know about technology—they said there's no such thing as zero discharge. You can't do that. But the thing of it is, you persistently bring this up. I went on three different

**SOMETIMES  
THINGS GET SO  
OUTRAGEOUS THAT  
YOU HAVE TO DO  
SOMETHING  
DANGEROUS INSIDE.  
YOU PUT YOURSELF  
AT RISK, OR YOUR  
PROPERTY AT RISK,  
AND YOU CREATE  
MIRACLES.**





hunger strikes on Formosa Plastics. I think the third one lasted thirty days. And you'd be surprised what your body can do. It really can go for thirty days. It don't take 'till noon to be hungry. You know you can go a long time.

There is something about being unpredictable—being unreasonable really worries them. At the very end I did use the legal system. I filed for every permit hearing. I even lost my attorney, so I started filing my own briefs. And I got a high school education and I'm not real logical or legally minded. And I wrote my own briefs to the EPA.

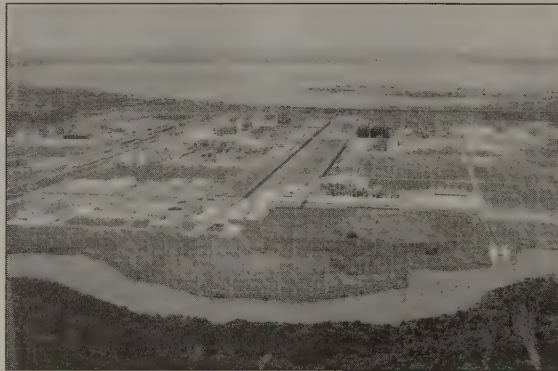
So you can do a lot of stuff. A lot of it was just waiting on something to start materializing. I firmly believe there is a key to the universe. There is like a universal law. It's like you put your commitment out there. You put yourself out there. I believe everyone is miraculous—they're all Gandhis. Sometimes things get so outrageous that you have to do something dangerous inside. You put yourself at risk, or your property at risk, and you create miracles. You can create events. I've had people come up to me and want to know what immense organization was behind me or who was directing me. And the scary thing was, there was nobody. It scared me at times. Because I kept thinking there's got to be somebody back there who knows what in the hell is going on and what I need to be doing. But there was nobody there. So you have to make the decisions, and they're hard decisions. I don't believe in having a safety net when making these choices and actions. They're scary decisions and you always know you're on the path because you can smell the fear. That's your own fear. And you head straight for it. I guarantee it. That's a real key I'm going to tell you there. You head for the fear. I think Gandhi, he talked about soul power, and this is what it is. It comes from your soul. It comes from being on your path. And you realize that there are things out there much bigger than your self and what you think you've got.

### THE SHRIMP BOAT THAT WOULDN'T SINK

Down on the Texas Coast, your shrimp boat is real important. You can live in a shack. You can have a rusty truck, but by God, you got a nice shrimp boat. For us, that's like a farmer with his farm. When I was fighting Formosa I had been on three hunger strikes trying to get them to zero discharge, and like I said, this is the irony of it: this is all federal law. You're not supposed to do this. You're not supposed to do that. You run a traffic light and the cop's going to stop you. Formosa was discharging into a bay system and they didn't have their permit. They were violating the law. Absolutely no permit. I was fighting. I had an appeal in

The Formosa Point Comfort Facility, subject of the Wilson-Formosa Zero Discharge Agreement. This \$2 billion

chemical and plastics manufacturing facility in Calhoun County, adjacent to Lavaca Bay, employs many local residents.



Shrimp life cycle. Water saved by the Wilson-Formosa Zero Discharge Agreement could be stored in the Lake Texana reservoir, which is required to make releases

that mimic the natural flow of rivers into the bay. The releases would coincide with the movement of brown and white juvenile shrimp into the secondary bay system (circled area).

Diane is a fourth-generation Lavaca Bay shrimper. Her work testifies to her commitment and sacrifice on behalf of her livelihood and the waters that allow her to live. She's fishing on a little skiff right now, for black drum. Diane continues to fight for zero discharge on several fronts: persuading DuPont

Washington. And everybody knew it.

To really get home to them how important this is and what is really going on, and to get things in perspective, that's when I took my shrimp boat. I had a forty-two-foot shrimp boat with a diesel engine much bigger than this podium here. I had to have a winch truck to pull it out. And the reason why I did that, was if I had sunk it with the diesel engine in it, they'd say oh, that polluting woman. That's awful. And here you have a chemical plant polluting every day, but a woman sinks a shrimp boat with an engine in it, oil in it, and she's a polluting woman. So I pulled the engine out and gave it away. I had a man sneak out and pull my shrimp boat out there in the middle of a norther, and I was going to sink that thing square dab on top of Formosa's discharge point.

Because I guarantee it, from then on they were going to have a monument to that discharge out there. And then about two-thirds of the way I had Coast Guard all over me; thirteen spent the night on the boat with me. And those Coast Guard can be real mean folks, I guarantee you they can be. They confiscated my boat for quite a long time. And I was called everything from—well, I've been called a terrorist. Even for hunger strikes they call it a terrorist.

I want to let you know, after that one, I got a zero discharge agreement from Formosa Plastics. It took about five or six years to get it from Formosa. But to give you encouragement, about a month later I went to Alcoa Aluminum, who had been the number one plant in the nation, as a matter of fact, for toxic disposal. I went to them and I said, "Now do we get a zero discharge agreement or do we do the whole thing over?" And in thirty minutes, they agreed to zero discharge.

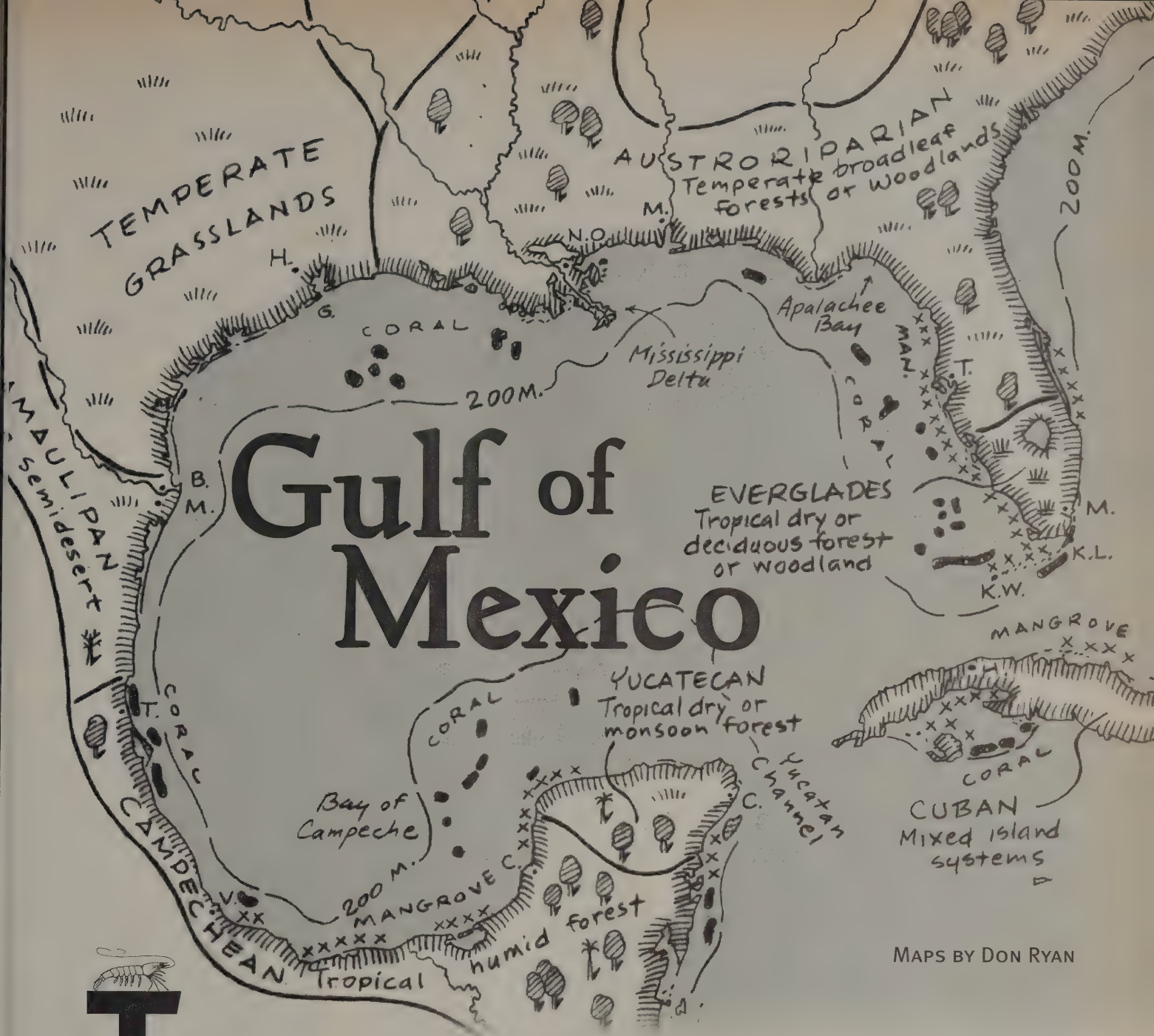
So anyway, I want to end this but I want to let you all know that I've got material on zero discharge. I have a lot of copies. I'll give everything I've got away. This document tells the technology and details the steps on doing zero discharge. How to do it in a plant, from the water balance to the resources, so you don't have to reinvent the wheel.

There's bad things out there, but the technique of getting out there and getting justice is like—I just want you all to believe, to know, that you can do it.

not to release its wastewater into the Guadeloupe River; working with an injured workers association that appreciates her ability to stand up to big industry; and organizing with unions in Texas City. Her activist group is Calhoun County Resource Watch, PO Box 383, Seadrift, TX 77983; 512/785-2364.

And that all you got to do is have belief in yourself and just be outrageous. That bay, to me, has a right to existence. We don't have to ask; we have to demand what is ours. ⊕





MAPS BY DON RYAN



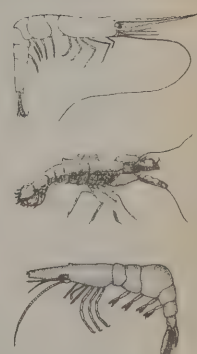
hough often compared to the Mediterranean, the Gulf of Mexico is a unique semi-enclosed sea. It was shaped by the largest known meteor to have crashed into the Earth, the extinction of a major bellowing deep sea crack in Gaia's crust, and the collision of three tectonic plates. The Gulf of Mexico welcomes one of the planet's major currents, the Loop Current, from the Northern Pacific, eddies and swings it by three nations and eleven states, and turns it completely around. T'ain't nothin', as they say in Texas.

The Gulf has swallowed many. African slaves, French and Spanish colonists, and Native American traditions (most of the peoples were exterminated) have stirred up the essence of the United States: the future's cuisine and down home blues. Texas coast

rice, Louisiana and Mexican cane sugar, Florida and Mexican citrus, palm and coconut oil, and shrimp and fish wreath the nearshore Gulflands.

Even before this recent history, Caribs boated from Havana to Tampa, and Mexican mound-builders are believed to have brought religion up the Mississippi. And, before that, hundreds of non-human creatures spread from the Caribbean and Mexico by land and sea and air, leaving a unique suite of species from Florida to the Rio Grande. Caribbean flamingos and crocodiles appear in Florida. Migrating birds—warblers, falcons—maintain the connection to their tropical origins.

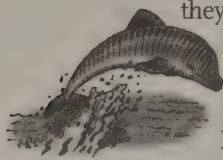
This is a region of snapper banks, shrimp grounds, lobster, crab, oyster, scallops, and deep-sea fishing. The limbo line of the Gulf's shore fluc-



Shrimp species: the white shrimp (above T), the arrow shrimp, the snapping shrimp, sargassum shrimp.



tuates on all time scales: strand, dune, and shell beaches, barrier islands; salt and freshwater marshes, bays, and lagoons; nearshore turtle grass pastures and mangrove swamps. Mostly,



they are in retreat from human appetite and thoughtlessness. Recreational and

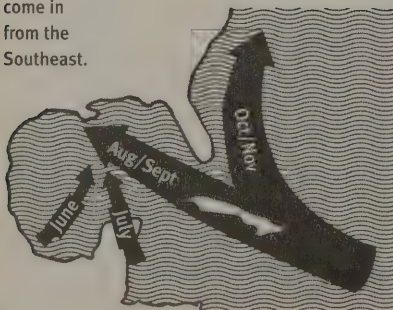
industrial developments and subdivisions along the whole Gulf Coast clash with tern and turtle nesting grounds as well as the stop-over and wintering habitats of migrating birds. Florida phosphate mines and upper Gulf sulfur extractions both fertilize inland soils and fragment coastal integrity.

Huge rivers pour into the Gulf. The Mississippi, the Usamacinta, the Everglades, and the Rio Grande used to nurture great fishing. Now they empty their altered sediment and the polluted runoff of every state they touch. River control and dams have shut down most flow in the Rio Grande, which has been



invaded by dozens of non-native fish. Along the Louisiana coast, land subsides faster than anywhere else in North America, and salt marshes turn to open bays more often than they should. The industries of Cancer Alley on the lower Mississippi, the Houston Ship Canal, and Galveston Bay piss their toxins into the Gulf. Scientists ponder the causes of red, green, and brown tides, massive fish die-offs, ailing coral reefs, and dolphin strandings.

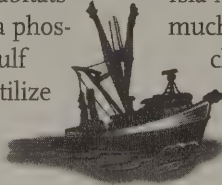
Early season hurricanes are rare, and tend to move north. The more frequent late season hurricanes generally come in from the Southeast.



Oceanic waters that started in the North Pacific, traveled around Asia and India, and bounced off the coast of West Africa pass through the Caribbean and the straits of Yucatán, then circle the Gulf. The Loop Current leaves the Gulf, turns north at the straits of Florida and becomes the Gulf Stream. The loop takes 500 to 800 years.

This is the bioregion of natural gas and oil, with onshore refineries and thousands of offshore drilling platforms. They hover ominously near beautiful salt dome-, rock-, and limestone-based coral reefs. Spills and platform fires are not under control.

The Gulf is the place where ecotourism, game fishing, commercial fishing, and just plain cheap flights for a tequila weekend of snorkeling can be the time of your life or turn the gumbo sour. El Garrafón and the Isla Mujeres reefs are dead from too much Cancún *turismo*. The shrimpers clash with the turtle-savers and conservationists worry about by-catch. Game and commercial fishermen clash with themselves and argue: is this decline a natural fluctuation or are we overfishing?

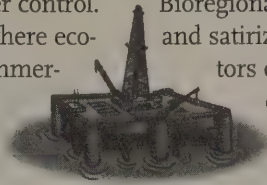


The Gulf Coast is a bioregion of essentially no snow and no history of glaciers. In the United States, the seasons between summer convection storms and winter frontals run the risk of drought. When winds die off the coast, larval and young invertebrates and fish have a hard time moving. Hurricanes like Dona, Camille, Hugo, and Andrew churn through the bioregion and send insurance companies begging for federal bailouts. Occasional volcanoes in the Yucatán veil the sun with ash.



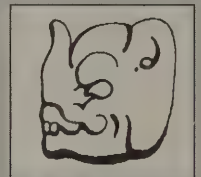
There are great spiritual and Earth warriors here. Upstream and Gulf Coast citizens have begun the struggle

for clean waters and edible fish and shellfish. The Seminole and the Mayans hold on. The decline of the pelican and whooping crane has been turned around. Coral reefs now have careful monitors and restorers. Bioregional writers sing of its beauty and satirize mercilessly the perpetrators of blind greed. It is a place of great hospitality, a mysterious Mardi Gras of petrochemical addiction, and home to wise fisherpeople who see and who speak with unpretentious words of what has been wrought upon our mother sea. —PW

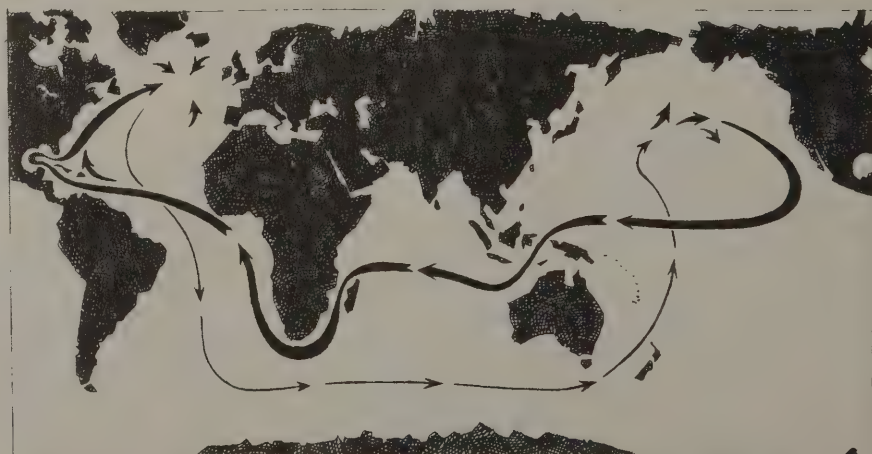
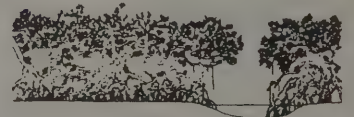


## Threatened Species

Listed here are approximately one-half of the Gulf's endangered species: whooping crane, leatherback turtle, hawksbill, five beach mice, Key West quail-dove, American crocodile, salt marsh diamond terrapin, as well as the extinct West Indian seal and Cape Sable marsh sparrow.



Extinct peoples: Atakap, Karankawa, Coahuiltecan, Comecrudo. Displaced: Natchez, Seminole (in part), and Choctaw.





# Gulf Cooking

Daphne Derven

Edges and boundaries are always where the interesting stuff happens. One of my favorite edges is the Gulf Coast, that amazing sort of circular area with its great natural beauty and volatile weather. Everything from this area is either mysterious, or done to extremes, or both. Color, weather, creatures, people, and food are all memorable. Here be the hurricanes and alligators, pirates and explorers, the mouth of the Mississippi, Spanish and French settlers, wild men and women (past and present). Even the air is voluptuous. If you haven't been to the Gulf Coast, you should go, but remember that many have never returned.

The climate and water provide a wealth of exotic fruits and fishes, seasonings and combinations. Never underestimate the level of extremes here. The ever-changing and ever-connecting Gulf of Mexico has moved people, cultures, and

their respective passions all over. The passion for one dish, blackened redfish, drove that entire species to the brink of extinction. The passion for money and power drove the African slave trade. The numerous Indian tribes who had lived on the bounty of the Gulf for generations lost home and health. All of these intersections and extremes are found on the Gulf table, on the plate, and in the food. There are those in the food world who believe that this is the cutting edge in our evolving American cuisine. Sugarcane, rum, bananas, coconut, seafood, filé powder (sassafras leaves), okra, corn, tomatoes, chile peppers, spicy seductive seasoning, color, and exotic combinations abound.

It is always difficult to capture regional foods. Like anything that is out of context, some elusive quality is frequently missing. Today's global market makes all the ingredients available. This is also an



area with wonderful music which is a big contributor to the atmosphere. Here are a few selected cookbooks which are my favorite sources of inspiration. You supply the attitude. ☺

Untitled,  
by Richard  
Thomas  
—THE DOOKY  
CHASE  
COOKBOOK

## The Dooky Chase Cookbook

Leah Chase. 1990; 224 pp. \$18.95. Pelican Publishing Company.

Leah Chase is an American treasure, and her food is full of heart and soul. This book is named after her restaurant (and her husband), and is the next best thing to eating there. My favorites include the breakfast shrimp with grits, gumbo *des herbes*, and the crawfish *étouffée*.

## The Frank Davis Seafood Notebook

Frank Davis. 1983; 272 pp. \$18.95. Pelican Publishing Company.

Frank was born with attitude and a passion for fish. He describes how to use every possible aquatic creature, most of which sound scary. Try his fried oysters, or his Louisiana seafood okra gumbo classique. I avoid the alligator recipes myself.

## The Star of Texas Cookbook

The Junior League of Houston, Inc. Staff. 1983; 373 pp. \$19.95. 1811 Briar Oaks Lane, Houston, TX 77027; 800/432-2665, 713-627-COOK, www.jrleaguehou.org.

Everyone contributed their best recipe. While some are better left alone, you definitely get a sense of what some folks serve at home. If you combine this book with Jessie Tirsch's, you'll get a nice cross-section of style.

## Sky Juice and Flying Fish Traditional Caribbean Cooking

Jessica B. Harris. 1991; 242 pp. \$12.95. Fireside/Simon & Schuster.

There is no better guide to the indescribable, exotic combinations and flavors of the Caribbean. Have a banana milkshake while you make escoveitched fish, or just read about the ingredients, recipes, and their cultural significance. If you trust her completely, Jessica Harris, a true woman of mystery, will elicit magic for your table.

## Fiesta A Celebration of Latin Hospitality

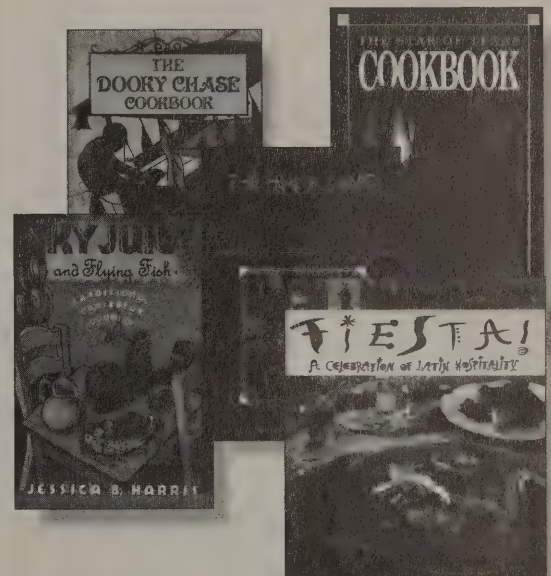
Anya von Bremzen. 1997; 388 pp. \$29.95. Doubleday.

Anya is a traveler who absorbs whatever environment she is in from the people and their food. Her recipes and cultural asides are almost as much fun to read as to cook. She definitely has attitude. Try the coconut and raw sugar flan, or yuca fries with tamarind ketchup.

## A Taste of the Gulf Coast The Art and Soul of Southern Cooking

Jessie Tirsch. 1997; 352 pp. \$25. MacMillan.

This book is a compilation of some wonderful recipes collected by the author from the home cooks along the Gulf.



## More Gulf Culture...

**Adios to the Brushlands**  
Arturo Longaria. 1997;  
118 pp. \$19.95. Texas A&M  
University Press.

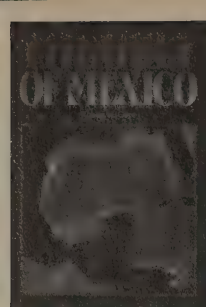
Personal memoir braided with borderland love and bioregional eulogy in a terrific work of integrated natural history.

**Naked Came the Manatee**  
1995; 201 pp. \$11.95 Fawcett  
Columbine/Ballentine.

Each chapter of this novel mystery is penned by a fine South Florida writer—you'll find the flavors of Carl Hiassen, Elmore Leonard, and Dave Barry along with ten others.







## The Gulf of Mexico

Robert H. Gore. 1992; 384 pp. \$24.95. Pineapple Press, PO Box 3899, Sarasota, FL 34230-3899; 941/953-2797, fax 941/953-2799, www.pineapplepress.com.

We could try to tell you why this book is the best one on the history and future of the land, water, and animals of the Gulf, but Dr. Darryl Felder has already done a better job of it in his preface:

"How, when, where, and to what degree should the non-specialist, the everyday citizen of America, Mexico, or Cuba become involved and make the "right" decision?..."

"The present work...[was] prepared intentionally as an

"Because plankton (or plankters, as the individual organisms are called) are so small, few people know they exist until

oceanic conditions become right to allow massive explosions of growth in numbers, termed *blooms*. Then, some species of

introduction and synopsis of salient factors operating in the Gulf today, it is 'user-friendly' and meant to avoid the intimidating terminology and theoretic in more technical works....But the format, albeit understandable and readable at the intelligent layman's level, does not soft-peddle the issues or, more importantly, ignore the critical background that fostered or promulgated these same issues in the first place. For the non-biologist, non-engineer, and non-attorney, this book provides a much needed guide that can substantially improve the understanding of the environments as well as the environmental issues that are having such an impact on the Gulf of Mexico today. And having such knowledge is the first step toward making the correct decisions."

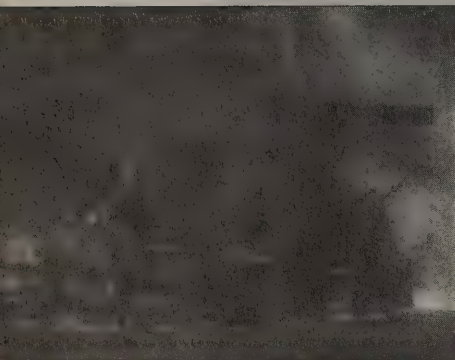
these tiny drifters may color the water for hundreds of miles, produce scintillating phosphorescence, or cause fish kills and release airborne toxins that cause human respiratory and eye irritation.

There are two major types of plankton in the world's oceans, plantlike drifters that use photosynthesis to make their own food from the dissolved nutrients of the sea, and animal or animallike drifters that feed upon the plant drifters. The former, called phytoplankton (phyto = "plant"), are

responsible for the basic or primary productivity that forms the basis for every single food web in the Gulf of Mexico.

"Through the mechanism of a million minor pollution events, mankind, like an insatiable colony of termites, is slowly nibbling the world ecosystems to death. No better example exists than in the Gulf of Mexico, where more than 800,000 acres of shellfish beds have been classified in terms of harvestability since 1971 as a direct consequence of point source (direct) and non-point source (diffuse) pollution. Some 720,000 of these acres are now partially or completely off limits for shellfishing. As noted in the House and Senate Merchant Marine Report for 1988: "The prevalence of contaminants in our coastal waters is rendering the unacceptable commonplace."

Just how bad could it be? Consider these facts....The waters of the Gulf of Mexico presently cover two inactive radioactive waste sites, 10 explosives and toxic chemical ammunition sites, 16 inactive industrial waste sites, one inactive ocean incineration site, over 35 dredged-material disposal sites, and over 20,000 oil and gas wells. And this doesn't even include debris and pollution from shipwrecks and other environmental accidents.



The oil tanker *Mega Borg* gasps out her final agony.

## Nature Books

### Fishes of the Gulf of Mexico

Texas, Louisiana, and Adjacent Waters.

H. Dickson Hoese and Richard Moore. 1998; 422 pp. \$18.95. Texas A&M University Press.

540 fish species have at last found some appreciation for their complex lives and places in the coastal marine ecosystem in this guide. Intensify your fish-identifying abilities and learn where certain fish are likely to be found and why. Color plates, keys to fish families, and descriptions of each family and species of fish.

### Beachcomber's Guide to Gulf Coast Marine Life

Nick Fotheringham and Susan Brunenmeister. 1989; 142 pp. \$12.95. Gulf Publishing Company, Book Division, PO Box 2608, Houston, TX 77252-2608, 713/529-4301.

What the heck is that? Rock louses and warty sea anemones on jetties and groins; starfishes and sea

pansies on sandy beaches; *sargassum* and purple men-of-war. Good biology lessons for the vacationer or the conscientious oil executive on a long lunch break.

### Roadside Geology of Texas

Darwin Spearing. 1991; 418 pp. \$16.

### Roadside Geology of Louisiana

Darwin Spearing. 1995; 223 pp. \$15.

These are the best introductions. Both from Mountain Press Publishing Company, PO Box 2399, Missoula, MT 59806; 406/728-1900.

### Ecology and Management of Tidal Marshes: A Model from the Gulf of Mexico

Charles Coultas and Yuch-Ping Hsieh. 1997; 355 pp. \$69.95. St. Lucie Press.

A pretty technical, but readable, manual, and worth taking a look at, though it's not really the whole Gulf, just parts of Florida.

## Gulf Coast Guardians: Mexico

### Texas Center for Policy Studies

PO Box 2618, Austin, TX 78768, 512/474-0811, fax 512/474-7846, tcps@igc.apc.org.

The top nonprofit providing research, technical assistance, and policy development services on Texas/Mexican environmental issues. Supports programs working to protect water quality, regulate pesticide use, and educate about the intersection of environment and property rights issues. Projects networking Texas and Mexico include examination of the impacts of toxic chemical pollution on environment and public health, and looking at alternatives for Laguna Madre. TCPS is also helping build the strength of Mexican environmental organizations.

### Ducks Unlimited Mexico (DUMAC)

US contact: Bob Streeter. 1709 New York Ave. NW Suite 202, Washington, DC 20006, 202/347-1530, fax 202/347-1533, bstreeter@ducks.org. Mexico contact: Eduardo

Carrera 52-83-78-6648 or 83-35-1212, fax 52-83-78-6349, ecarrera@infocel.net.mex.

These folks have conducted extensive work in all of Mexico's Gulf states for many years: wetlands studies/management plans, habitat and water quality surveys, a research facility in Celestun where they help train *Reserva* managers, and development of nest boxes for endangered native duck species.

Also check in on the US Fish and Wildlife Service, Partners in Flight (page 19).

### The Nature Conservancy Mexico Program

Bob McCready, Northeast Mexico Program Manager, PO Box 1440, San Antonio, TX 78295, 210/224-8774. Andrea Erickson, South Mexico Program Manager, Calle 31, Col. Alcala Martin, #503 x 60 y 60a, CP 97050, Merida, Yucatán, Mexico, 52-99-202003.

From restoring the major binational wetland of Laguna Madre to saving one of the last parcels (privately

owned) of Tamaulipan thornscrub to helping manage Yucatán estuaries and habitat, TNC plays a major role in funding and training regional NGOs and in spearheading protection for the less industrialized (for now) Mexican Gulf Coast.

### Pronatura Peninsula de Yucatán (PPY)

Calle 1-D # 254-A entre 36 y 38, Col. Campestre, CP 97120, Merida, Yucatán, Mexico, 52-99-44-2290, fax 52-99-44-3580.

An independent nonprofit branch of the national *Pronatura*, PPY is involved in the management plans for the Celestun and Rio Lagartos UN-designated biosphere reserves in Yucatán—inland estuaries that go directly to the Gulf, *Pronatura* helps preserve the mangroves, flamingoes, shrimp, and alligators for whom these wetlands are home. There is also a *Pronatura* branch that works in northeast Mexico (*Suc. de Correos "J" C.P. 64849, Monterrey, N.L., Mexico; 52-8-328-4033*). Significant funding and advice comes from the Nature Conservancy.



## Gulf Coast Guardians: US

### The National Estuary Program

EPA (4504F), 401 M Street, Washington, DC 20460, 202/260-6502, fax 202/260-9960, OWOW-web@epamail.epa.gov, www.epa.gov/OWOW/estuaries/nep.htm.

Valiantly protecting the livers and kidneys of our aquabodies, seven of the twenty-eight NEPs operate in the Gulf: Charlotte Harbor, FL; Sarasota Bay, FL; Tampa Bay, FL; Mobile Bay, AL; Barataria-Terrebonne, LA; Galveston Bay, TX; and Corpus Christi Bay, TX. The best way to get a feel for their individual natures is to browse the Program Profiles on the NEP website—they include priority management issues, major habitat types, endangered and threatened species, maps, and highlights of each community-based endeavor to improve the quality of the estuaries and the whole Gulf. Then write to the office you're interested in, and if they are anything like the stellar Corpus Christi Bay outfit, prepare yourself to dive into heaps of well-written literature about well-managed, well-studied, effective action, such as their long-term, comprehensive Coastal Bend Bays Plan.

### Galveston Bay Foundation

17324-A Highway 3, Webster, TX 77598, 713/332-3381, fax 281-332-3153, www.galvbay.org.

A nonprofit whose top priority is to re-establish habitat in Galveston Bay by site-specific projects. Working closely with the Galveston Bay National Estuary Program, their goal is to bring back 15,000 acres of wetlands over the next ten years using education, conservation, research, and advocacy.

### Coalition to Restore Coastal Louisiana

200 Lafayette Street, Baton Rouge, LA 70801, 888-LA-CAST, 504/344-6555, www.crcl.org.

A nonprofit educational organization that has played a major role in bringing Gulf Coast issues to state and national attention, resulting in significant legislation. CRCL helps select restoration projects under CWPRA, con-

ducts major land use and development studies along the Mississippi, and hosts numerous summits and workshops to bring more public participation into their discussion, planning, and educational efforts. The coalition publishes *Coastal Currents*, a monthly newsletter, and *Coast Wise*, their semi-annual magazine.

## ALABAMA Rivers ALLIANCE

**Alabama Rivers Alliance**  
700 28th Street South, Ste. 202G, Birmingham, AL 35233, 205/322-6395, www.auburn.edu/~masucmm/alriver.html.

With a relative sliver of actual coast, some Alabamans figured that it is through protection of their rivers and watersheds that they can best contribute to the overall health of their state as well as the Gulf of Mexico. The **Alabama Rivers Alliance** watch-dogs the state and its strategies for bringing rivers up to standards. The **Alliance** advocates pollution budgets called Total Maximum Daily Loads. **ARA** works hard to help local river friends organize—groups such as the Cahaba River Society, which works on greenways along streams as well as stormwater management programs to reduce toxicity of runoff, and West Bay Watch, which is challenging the air pollution permit for a proposed phenol manufacturing center in Mobile County. **ARA** publishes the *Directory of Alabama Watershed Guardians* (\$5 for members, \$10 for nonmembers) as well as their quarterly *River Ties* newsletter.



### Flower Garden Banks National Marine Sanctuary

216 W. 26th Street, Ste. 104, Bryan, TX 77803, 409/779-2705, fax 409/779-2334, flower\_gardens@ocean.nos.noaa.gov.

The Flower Garden Banks are surface expressions of

salt domes beneath the sea floor. The National Marine Sanctuary protects and studies 56 square miles that are home to the northernmost coral reefs in the United States, roughly 110 miles south of the Texas-Louisiana border. **FGBNMS** offers opportunities for hands-on observation and participation through research cruises and dives for educators, scientists, and Regular Joe volunteers who help monitor, survey, and census marine life and habitat conditions, from examining coral genetics to satellite tracking of sea turtles to a 3-week mapping project aboard a Navy sub.

### The Marine Mammal Stranding Network

5001 Avenue U, Suite 105C, Galveston, TX 77551-5962, 409/740-4455, tmmsn@tamug.tamu.edu, www.tmmsn.org.

"Dedicated to understanding and conserving marine mammals," **MMSN** saves, rehabilitates, and studies stranded dolphins and whales. Also educates through research, necropsies, and lectures.

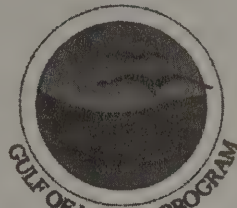


### Coastal Wetlands Planning, Protection, and Restoration Act (CWPRA) Task Force

Jay Gamble, Outreach Coordinator, PO Box 60267, New Orleans, LA 70160-0267, 504/862-2786, www.lacoast.gov.

The projects funded by **CWPRA** all focus on marsh creation, restoration, protection, or enhancement nationwide. It designates approximately \$35 million annually for work in Louisiana's nine hydrologic basins, the state with 40% of the lower 48's coastal wetlands. The **Task Force** is made up of five federal agencies and works with various state offices. Their website links to many projects, their goals, timelines, monitoring, etc.—plus you'll learn some mind-boggling statistics about Louisiana: the commercial fishing

industry harvests more than 1.1 billion pounds of finfish and shellfish annually; it is habitat for more than 5 million wintering waterfowl; recreational fishing revenues equal \$235 million per year; gas and oil production are worth \$37.4 billion per year; and a waterborne commerce industry moves 400 million tons of products through coastal channels every year, more commodities than the entire West Coast.



### The Gulf of Mexico Program

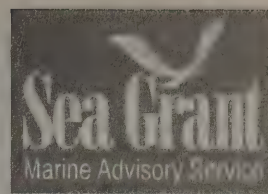
Building 1103, Room 202, Stennis Space Center, MS 39529-6000, 601/688-3726, fax 601/688-2709, http://pelican.gmpo.gov.

Incorporates federal, state, and local government agencies, business and industry, nonprofit and educational groups, and individuals through incentive-based programs to improve and protect the Gulf's resources.

Four environmental priorities: 1) restoration of shellfish growing waters and reefs; 2) hypoxia (oxygen deficiency) linked to excessive nutrients (1/3 of the estuaries are experiencing this problem or will be potentially affected); 3) habitat loss; 4) introduction of nonindigenous species. These can be read about in their free bimonthly newsletter, *GulfWatch*.

Example projects: With the Mississippi Department of Marine Resources, **GMP** can track the movement of red tides along the coast with remote sensing monitoring. The technology provides early alerts of the red tides, allowing the **DMR** to permit oyster harvesters to double their catch limit prior to an approaching tide, and to close the beds when the red tide makes harvesting oysters a health hazard.

In Bayou Cubest, MS, the **GMP** provided more than \$80,000 to install alternative onsite sewage treatment systems in more than 30 homes, correcting the discharge of human waste into the Bayou.



### Texas Sea Grant College Program

1716 Briarcrest, Suite 603, Bryan, TX 77802, 409/862-3767, fax 409/862-3786, txseagrant@unix.tamu.edu, http://texas-seagrant.tamu.edu.

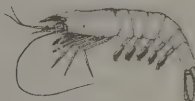
**Sea Grant** is a national partnership program consisting of academia, government, and industry operating through a university-based network.

Most funds come from the federal government with matching support from the Texas Legislature. It currently supports projects in aquaculture, biotechnology, environmental studies, fisheries, marine education, marine business, seafood sciences and technology, and sociological, economic, legal, and policy studies. They publish *Texas Shores* quarterly (free to Texas residents, \$7.50/year elsewhere).

### Gulf of Mexico Foundation

5403 Everhart, No. 51, Corpus Christi, TX 78411-4843, 512/882-3939, www.sci.tamucc.edu/gmf/projects/ecosys.htm.

Comprehensive ecosystem monitoring and modeling projects through outside grants, such as the Gulf of Mexico Program/EPA. Also hosts the River's End Economic/Environmental Conference to conduct an international discussion of the Rio Grande. Publishes the *Monitor* quarterly.

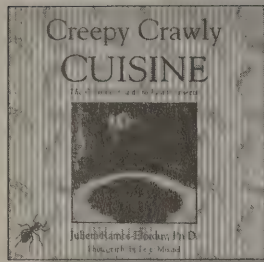


More shrimp species: the rock shrimp, the sugar shrimp.



## Creepy Crawly Cuisine

The Gourmet Guide to Edible Insects



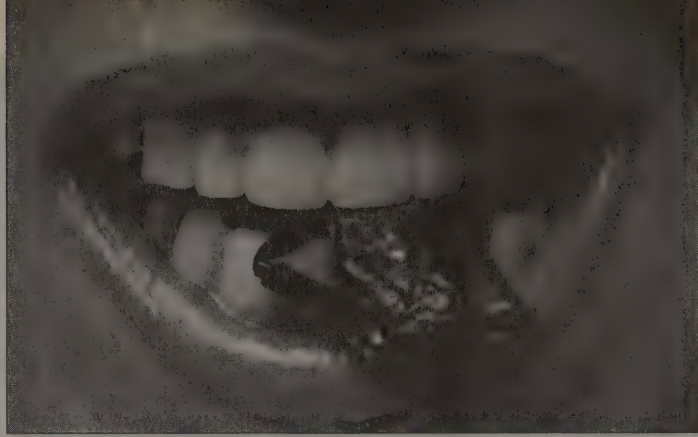
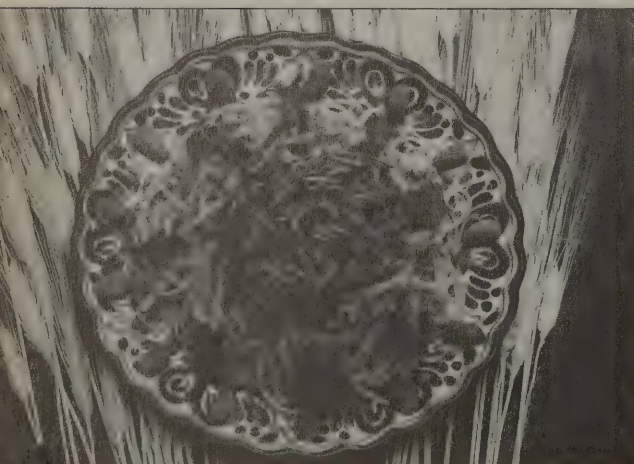
Julita Ramos-Elodury, with photographs by Peter Menzel. Translated from the Spanish by Nancy Esteban. 1998; 150 pp. \$16 (\$19.95 post-paid). Park Street Press, One Park Street, Rochester, VT 05767, 802/767-3174.

With regard to global food issues, there are 1,417 species of edible insects; 573 of these occur in the Americas. The largest numbers are types of beetles, grasshoppers, cockroaches, crickets, butterflies, and moths. In many parts of the world, insects are daily and/or prized foods. Insects are prolific breeders and have short life spans, so there is a vast supply. Further, they are an excellent source of protein. **Creepy Crawly Cuisine** includes tables providing nutritional values and amino acid and protein statistics for various insects. I learned here that the Insect Club, a restaurant in Washington, DC, uses 25,000 crickets and 25,000 mealworms on a daily basis in its recipes. In addition, the book lists sources for purchasing edible insects, pertinent publications, a bibliography, and creepy crawl events (my favorite was the Bug Bowl at Purdue University, featuring insects as art and cricket-spitting contests).

### “ FLAVORS

Ants—sweet, almost nutty  
 Black witch moth larvae—herring  
 Central agave worms—kidney beans  
 Corn earworms—corn on the cob  
 Crickets and grasshoppers—mild, taking on surrounding flavors  
 Dragonfly larvae and other aquatic insect larvae—fish  
 Leaf-footed bugs—very sweet pumpkin  
 Nopal worms—fried potato  
 Red agave worms—spicy  
 Stinkbugs—apple

Mealworm spaghetti.



spinach leaves for some contrast. Or you might prefer *Stink Bug Pate*, but I eliminated

This is serious stuff and bears no resemblance to those chocolate-covered ants. I confess that on the urging of an anthropologist friend I have captured and eaten my own country, though not city, ants. No, they did not taste like chicken, and yes, they were crunchy. I agree with the author's assessment of ants as having a sweet, almost nutty flavor. I can't speak to her comparison of leaf-footed bugs to very sweet pumpkin.

To provide some sense of the scope of the recipes in **Creepy Crawly Cuisine**, I selected some recipes that, in combination, would create a meal. I do strongly urge you to consider, in both kitchen and dining room, a liberal quantity of mescal, preferably with the worm. For the appetizer, my recipe and visual favorite was the *Leaf-Footed Bug Pizza*, which is your average pizza with the addition of large black beetles strewn decoratively on top. Personally, I would add

Termites—nutty  
 Tree worms—pork rinds  
 Treehoppers—from avocado to fried zucchini  
 Wasps—pine nuts  
 Water boatmen (adults)—fish (when fresh), shrimp (when dried)  
 White agave worms—cracklings  
 Yellow mealworm beetle larvae—whole wheat bread

“ Although it might seem unthinkable to suggest not washing your insects before you eat them, that is what I recommend. The pheromones of insects, which are responsible for a significant amount of their smell and taste, are lost when insects are washed. Of course, insects are still delicious if washed and prepared with condiments (for an alternative flavor), but their original, unique taste certainly will be diminished. Insects manufacture antibiotic substances in their exoskeleton that do not allow for the existence of any dangerous microorganisms, and during the frying process any germs will be killed with a cooking heat above 410° Fahrenheit. So leave the insects as they are—and if you find a leaf or a speck of dirt that needs to be removed, do so with your fingers!

that because it uses powdered bouillon. Next, speaking of contrast, the *Mealworm Spaghetti* (which looks like you think it would) could do with some color; I would suggest several handfuls of chopped basil. Follow with *Batter-fried Dragonflies* and *Wasp Salad*. For dessert, *Chicataná Empanadas* or *Ant Turnovers*.

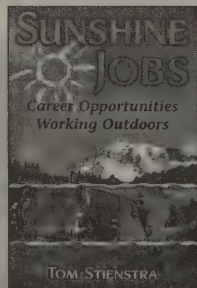
They say that most people who buy cookbooks read them, but never use the recipes. I suspect that may really apply to this book. It is important to point out, however, that the author is a prominent and highly regarded professor at the Institute of Biology at the National University of Mexico in Mexico City. She has devoted twenty years of research to investigating insects and their edibility. Peter Menzel's carefully styled color photographs are graphic and clear. Dr. Ramos-Elodury is challenging us to forego our prejudices and to look to future food-supply insects. —Daphne Dervin

## Sunshine Jobs

Career Opportunities Working Outdoors

Tom Stienstra. 1997; 425 pp. \$16.95 (\$19.45 postpaid). Live Oak Publications, PO Box 2193, Boulder, CO 80306, 303/447-1087, fax 303/447-8684.

River rafting involves tough training, long hours, biting insects, big responsibility, and significant physical discomfort. And you have to like people—your customers have



### “ (PACK TRIP GUIDE)

The idea is that you do not have to carry your gear. It is instead packed on the back of an animal, hence the “pack” in pack trip.

Thus the focus for a guide is less on physical demands, and more on the ability to communicate, set up a camp, cook, clean up, know first aid, and demonstrate skills of woodsmanship. It is one thing to be a good woodsman, you will discover, and



**The Great Sunflower Book**  
**A Guidebook with Recipes**

Barbara Flores, photographs by  
 Lois Ellen Frank. 1997; 130 pp.  
 \$15.95. Ten Speed Press.

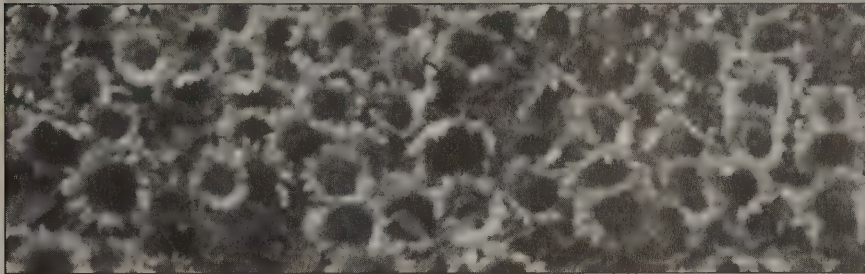
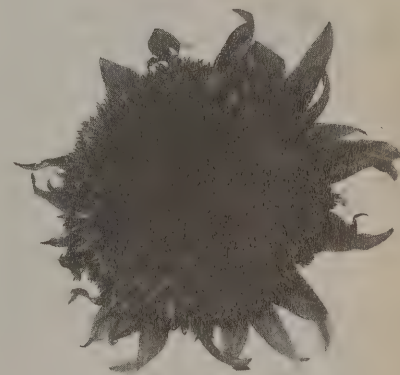
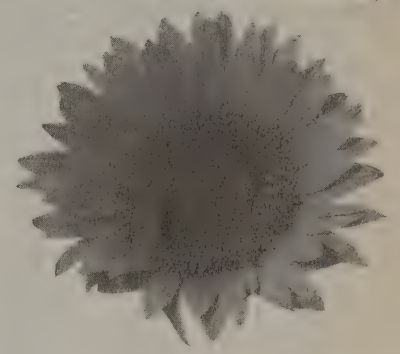
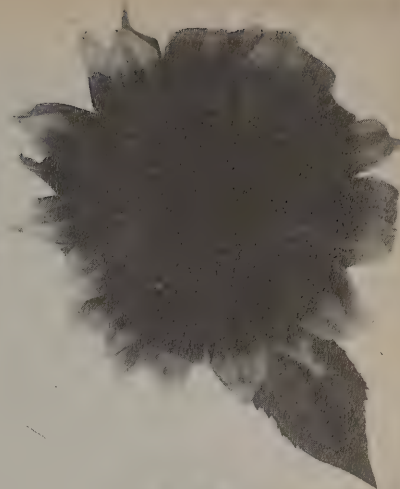
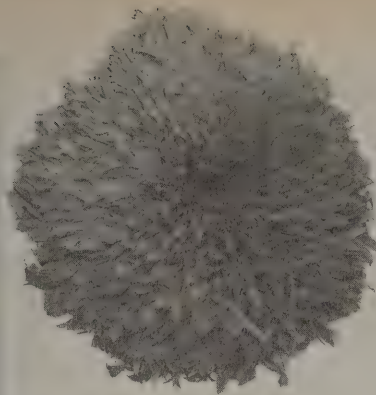
This could be subtitled *Sunflowers Rule!* One of the earliest plants domesticated in North America, sunflowers have provided oil, dye, medicine, and food for about 3,000 years. They are now cultivated around the world. Sunflower oil is widely used in cooking. We've all tried the seeds. The liquid from the stem is said to cure the irritation caused by poison ivy. Sunflowers have even been used in Chernobyl, where their roots helped clean a contaminated pond—the plants then had to be disposed of as radioactive waste! Few plants can claim such beauty in addition to such diverse and historic uses.

That said, sunflowers have always struck me as evidence for the existence of space aliens. I have spent a lot of time in the Midwest; the fields I saw there were scary—covered with plants over ten feet

tall, who turned to face the sun.

I really enjoyed this book. The historic information, gardening tips, and recipes are enlightening and accessible. The Apple Sunflower Strudel was delicious. Though I didn't try them, some recipes were literally for the birds. Looking at the images, the diverse beauty of the sunflowers forced me to believe that I should alter my opinion that sunflowers = space aliens.

Until, that is, I reached the part about the largest sunflower head, which measured more than thirty-two inches wide, and the tallest known sunflower, with a flower head reaching over twenty-five feet above the ground. Okay, so the smallest sunflower was only about two inches tall. Ever watch the "X-Files"? —DD



chosen you to be their guide and teacher. On the other hand, you get paid to run beautiful, challenging rivers. How do you start? What's the pay? Is there a future in river running? Tom Stienstra, outdoor writer extraordinaire, introduces you to the trade with honest descriptions (strongly resembling my own experience as a river guide) bolstered by interviews with people doing the deed. He treats forty-nine more outdoor professions in the same straightforward manner—fire tower lookout, bait shop owner, Peace Corps volunteer, tree planter. Tempting! (What am I doing here beating this keyboard?) —J. Baldwin

another thing entirely to be a good guide.

“(PARTY BOAT DECKHAND) He didn't understand that the boat's got to be made ready before you leave: you've got to get the tackle ready, cut the bait, get all the passengers on and through the trip, clean the fish, and clean the boat. At the end of the day he said to me, "Lee, there's a whole lot more to this than fishing." I said, "Paul, fishing is the easy part.”



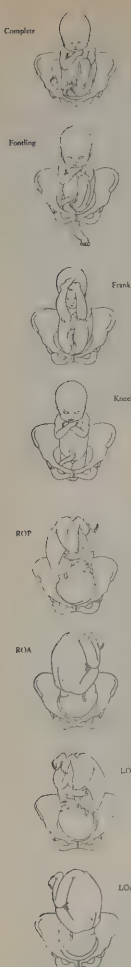
“Czar Peter I of Russia (Peter the Great) traveled to the Netherlands in 1697 and encountered sunflowers for the first time. He enthusiastically carried fertile seed samples back to Russia, where, initially, only horticulturists at the St. Petersburg Botanical Garden grew them. But soon, farmers in central Russia, blessed with thick black soil, were producing larger and healthier plants than western Europeans had ever seen—some grew to fifteen feet. Sunflower seed rapidly became the source of oil for the Russians, who led (and continue to lead) the way in the development of sunflowers as a major world food source. The plants were too new to have been proscribed by the Russian Orthodox Church, and thus not included in a list of high-fat crops that could not be eaten during Lent. Followers of the Church could obey the law to the letter and still obtain a much-needed high-energy food source by eating sunflower kernels.

Left: Dwarf Sunspot. This recently developed plant offers full-sized, ten-inch flowers on dwarf plants just one to two feet tall.

Top to bottom: Lion's Mane, Gloriosa, Sunbeam, Dragon's Fire, Lemon.







Fetal breech presentations and vertex positions.

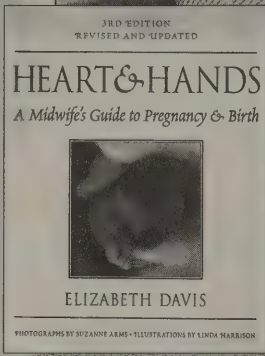
Above right: Assisting at home births affords the chance to share in a team effort and to experience birth as normal.

## Heart & Hands A Midwife's Guide to Pregnancy & Birth

Elizabeth Davis. 1997; 287 pp. \$21.95.  
Celestial Arts.

Midwife means "with woman"; if you want a birth practitioner who views birth as a natural process rather than a medical procedure, who will pay more attention to nutrition and counseling, and who will guide you throughout active labor rather than pop in at the last moment for "the catch," then you should probably choose a midwife rather than a doctor. Written by one of America's leading direct-entry midwives for other midwives, **Heart & Hands** is also a marvelous resource for any woman (or partner thereof) who really wants to understand the processes of pregnancy and birth. The book provides all the information regarding physical assessment, labor, and delivery, along with fabulous medical illustrations by Linda Harrison and photos by renowned birth advocate Suzanne Arms.

Most importantly, it offers detailed advice on handling the equally significant emotional aspects of pregnancy and birth. The chapter on difficulties in pregnancy includes estranged couples, lesbians, single mothers, and abuse issues, along with high blood pressure and postpartum. Among the labor trouble discussions is a moving and detailed account of stillbirth that is both harrowing and compelling, drawing focus to an issue often downplayed or ignored in pregnancy guides. The final chapters—on becoming a midwife and the midwife's practice, are a must for anyone considering this fulfilling and arduous profession. —Naomi Yavneh



“Unlike most obstetricians who prefer to make an episiotomy for a variety of rationalizations, midwives take great pride in maintaining an intact perineum. This is the

hallmark of a real midwife and is genuine proof of her patience and loving touch. Nevertheless, tears occur commonly and sometimes surprisingly....

After the first 15 or 20 deliveries, every midwife has had to reckon with a few serious tears. They are simply going to happen, no matter how ideal things are. In fact, she may even decide to do an episiotomy on rare occasions, and this

is usually considered part of the province of surgery, with firsthand experience not easy to come by. Although it is a skill best acquired by actual practice, it requires understanding and rehearsal in advance.

“Most midwives routinely provide comprehensive prenatal care, personally seeing their expectant clients at nearly every visit. Only by giving continuous care can the midwife get to know a woman well enough to have some sense of what to anticipate at her birth. Prenatal assessment is the cornerstone of midwifery care; the better we do our work prenatally, the less we are surprised by long, drawn-out labors. Every expectant mother's physical and emotional condition is unique, and can only be appreciated by repeated, regular contact. This helps us build rapport and a solid working relationship, and is what we call *continuity of care*.

## The Womanly Art of Breastfeeding

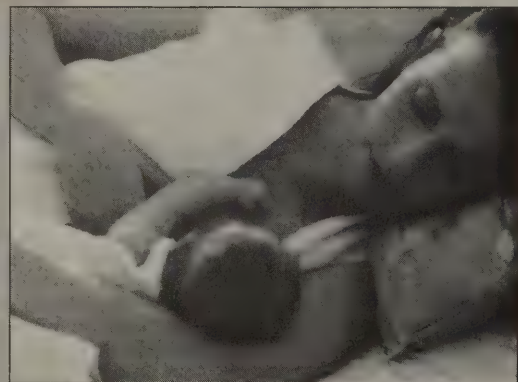
La Leche League International. 1997; 465 pp. \$14.95. La Leche League International, PO Box 4079, Schaumburg, IL 60168-4079, 800-LA LECHE, www.lalecheleague.org.

I was kind of put off by the hokey title—until I found myself at two a.m., propping the book open with my feet and struggling to nurse a howling newborn as milk spurted from my engorged breasts. Having spent seven of the past eight years nursing babies and toddlers, I am now an expert, but I still turn to **The Womanly Art**, now in its sixth edition, for advice and support. La Leche League International is unequivocally the *best* source of information on breastfeeding. **The Womanly Art** is the

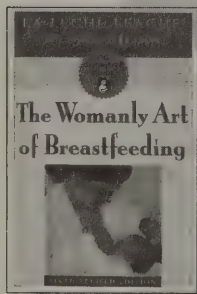
best single book to own if you want to breastfeed your baby successfully. Comprehensive, comprehensible, and

helpful, the book offers detailed information regarding such standard subjects as positioning, building up milk supply, introducing solids, and weaning, along with less common fare like tandem nursing (nursing an infant and a toddler), nursing a child with a disability such as Down Syndrome or cleft palate, or nursing an adopted or premature infant.

Following League philosophy, the book emphasizes the considerable emotional as well as astounding physical benefits of breastmilk and breastfeeding for both mother and child. And the discussion of such issues as toddler nursing and fitting breastfeeding into your family are excellent. Unless you're very lucky, the information in **The Womanly Art** is tons more accurate than what you'll hear from your doctor, who may very well get her information on breastfeeding from the formula companies. This book will show you why and how breastmilk and breastfeeding are magical. —NY



“Your milk can actually protect your baby from getting sick when you have a cold or the flu. A nursing mother produces antibodies to the specific germs her baby has been exposed to. These antibodies are transmitted to the baby through her milk. Continuing to breast feed also helps you get the extra rest you need when you aren't feeling well. Sudden weaning would not be good for either you or your baby.

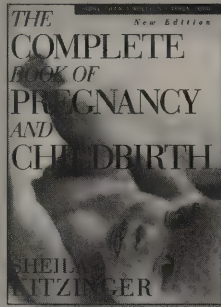




## The Complete Book of Pregnancy and Childbirth

Sheila Kitzinger, photographs by Marcia  
May, 1996; 432 pp. \$24. Knopf.

Although the information isn't organized in the month-by-month format that makes the best-selling *What to Expect When You're Expecting* so user-friendly, Sheila Kitzinger's **Complete Book of Pregnancy and Childbirth** is a best bet for the woman who wants a healthy and informed pregnancy. Kitzinger considers such issues as the choice of practitioner and the place of birth, prenatal care, labor, delivery, and newborn care. There is also a glossary, a guide to understanding your medical



records, a chart for determining your EDC (due date), and a week-by-week account of fetal development—along with a fabulous description of what birth is like for the baby.

What really sets this book apart is Kitzinger's approach to birth, which is "based on the idea that the woman is active birthgiver rather than a passive patient" and her focus on birth "as experience rather than as a series of exercises in breathing and relaxation." And unlike most other pregnancy guides, she gives special attention to the concerns of single or low-income mothers.

Whether or not you believe in natural childbirth, I guarantee this book will be your constant companion from the first trimester on—and without that ridiculous "best odds" diet. —NY

Hands

7 weeks

8 weeks

13 weeks

Feet

7 weeks

8 weeks

13 weeks



Hands and feet develop at a slightly different rate, the feet being about a week behind the hands until the 13th week.

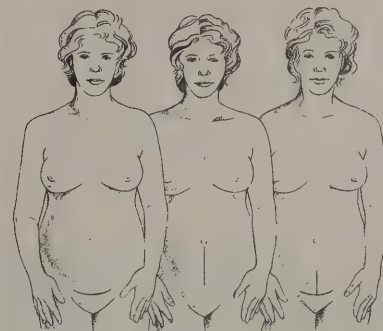
ally far less interested in the next pregnancy and may even raise their eyebrows and criticize you if you already have three children or if you are pregnant again after a short interval. They can make you feel what you are doing is not very public-spirited and even socially harmful. Some women say they were asked "Do you want it?" or "Don't you think you've had enough?"; others cite sympathy offered by well-meaning friends: "How ever will you manage?"

flexibility and resourcefulness on the part of both parents. In some ways things are much easier: you know what to expect and have probably developed self-confidence in your role as childbearer. You may sail through the pregnancy with style. But there may be difficulties which come as a surprise because you thought it would be simple this time....

The first problem you may encounter is the reaction of other people to a new pregnancy. Whereas your first was greeted with delight, friends and relatives are usu-

Written in lucid, relaxed prose and peppered with first-hand accounts by a wide range of women whose experiences underscore the points Korte makes, the **Companion** is organized into three parts. "Understanding" includes an excellent discussion of overcoming fear. "Planning" addresses choosing VBAC-friendly practitioners, using your insurance wisely, and places of birth, including home birth, a rarity in books about VBAC. "Giving birth" is the third segment that incorporates both the experience and the appreciation of the event.

There are also a broad-ranging and well organized bibliography and appendices on infant mortality, c-section, and VBAC rates from a variety of countries. Although Korte obviously cares deeply about her subject, she is not at all preachy, and her discussion of repeat cesareans is sensitive and reassuring. Similarly, her book offers a broad perspective on choices (OBs, certified nurse-midwives, and direct-entry midwives; hospitals and birth centers; natural and medicated births) without insisting on any one way: what is important is for each woman to make the right decision for herself. —NY



From left to right: low-transverse incision, classical incision, and inverted T incision. Since the mid-1980s, 99 percent of cesareans have been performed with the low left-to-right horizontal (transverse) incision. This is the safest type because it is the least likely to rupture.

“Look for the professionals who offer you what you want, instead of trying to fit what you want into what they do. This is true whether you want a high-tech pregnancy and birth or whether you're looking for a midwife to assist you with unmedicated childbirth. As you interview possible doctors and midwives, eliminate the people who you know will not give you what you want. Remember you're looking for cooperation and enthusiasm, not reluctance.

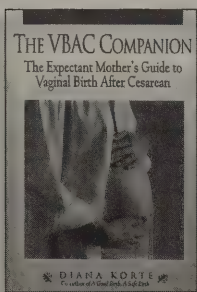
“Eight weeks pregnant: The baby is still smaller than your little toe. It floats in the amniotic sac like an astronaut in space, attached to its life-support system. The heart has started the vigorous pumping of blood which will continue for a lifetime. The brain already shows through skin as thin as waxed paper, revealing every tiny branching blood vessel beneath.

“Pregnancy the second or third time around is a new experience. It will not be exactly like the first time. It holds different challenges. Coping with them involves

## The VBAC Companion The Expectant Mother's Guide to Vaginal Birth after Cesarean

Diana Korte.  
1997; 240 pp.  
\$12.95.

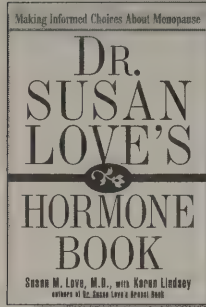
The Harvard  
Common Press.



While some women approach a c-section with a sense of resignation, acceptance, or even relief (finally, they got that baby out of me!), for many a surgical delivery—however successful the outcome—is a frightening, painful, and disappointing experience. Moreover, at least until recently, standard medical practice was “once a cesarean, always a cesarean.” Indeed, one (but certainly not the *only* reason for the skyrocketing cesarean rates in this country) is the overwhelming number of second and third such surgeries. Fortunately, the tide is turning; if you want a VBAC (vaginal birth after cesarean), this book will tell you how to get one.



**Dr. Susan Love's Hormone Book**  
**Making Informed Choices**  
**about Menopause**



Susan M. Love with Karen Lindsey. 1997; 362 pp. \$25. Random House.

My gynecologist, with whom I enjoy a remarkably egalitarian and respectful relationship, has begun painting a rather grim picture of what the future holds for me without benefit of hormone replacement therapy (HRT).

My skin and hair will thin; my muscles go slack; my bones crumble. My heart will become treacherous and unpredictable. But of all the terrible ailments and infirmities he describes, I confess that the one that grips my entrails with fear is that most dreaded of maladies—the atrophied vagina! It is no wonder then that it is the hormone Premarin, and not the ubiquitous

“Margaret Lock did a survey of menopausal symptoms in Japan.... Interviews with doctors confirmed these findings. Thirty doctors were questioned for this study, and all said that the symptoms their menopausal patients complained of most were shoulder stiffness, headaches, and dizziness. The equivalent words for hot flashes were near the bottom of their list of symptoms; some didn't even include them at all. “Every Japanese doctor interviewed during the survey and since that time confirms that hot flashes are not symptoms about which Japanese women consult a doctor,” writes Lock. Women hadn't been going to their doctors with menopausal symptoms: when they did go, they consulted primary care physicians, not gynecologists or psychologists. Yet Japan is an extremely health-conscious nation with a high doctor-patient ratio and universal health insurance, with easy access to health facilities.

But changes are brewing. For the past two years, the subject of menopause has suddenly been taken up repeatedly in Japanese women's magazines. The supposed long-term benefits of hormone therapy have been emphasized, including its alleged effectiveness against dementia, stroke, heart disease, and osteoporosis. Many articles have indicated that hormone therapy can help women recover their youth. The medicalization of menopause is creeping into Japan.

Japanese women have a life expectancy of nearly eighty-two years—higher than ours. It's true that, like American women,

mood-altering Prozac, that is the most prescribed drug in the US. Equally unsurprising is the avalanche of books about menopause, perimenopause, and HRT spawned by the marketing strategy of publishers and the demographics of health care.

Into the resulting confusion and contradiction steps the author of *Dr. Susan Love's Breast Book*, respected as a surgeon and medical school professor, admired as an activist for women's health, and notable for the strength of character that allows her to break ranks with many of her peers by questioning the oft-touted wonders of HRT. Love carefully examines the controversies surrounding HRT, offering the reader knowledge and information, rather than opinion, and encouraging each of us to make our own decisions. Written under the influence of her own hot flashes, this is the book so many of us have been waiting for: carefully considered, well researched, grounded in traditional medicine but informed and excited about non-traditional alternatives. —Patricia Pettijohn

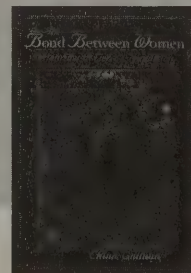
Japanese women have osteoporosis at twice the rate of men—in part, at least, because they live longer. Yet osteoporosis...is only half as common among Japanese women as among American women....As for coronary heart disease, the mortality rate of Japanese women is a quarter that of American women. The mortality rate from breast cancer is a fourth to a third that of North American women. Japanese women drink little alcohol, exercise continuously throughout their lives, and rarely smoke. Apart from a high consumption of pickled foods, they eat a well-balanced diet with a lot of soy products and no milk....It's beyond me why they'd want to interfere with what seems like a winning system by introducing hormone therapy.

**The Bond Between Women**  
**A Journey to Fierce Compassion**

China Galland. 1998; 344 pp. \$25.95. Riverhead Books.

How about a large, smiling, ferocious, ten-armed, lion-riding woman as an image of the sacred? The Hindu goddess Durga is one

“I want empowerment from a woman, from this self-realized healer who has enough confidence to follow her own wisdom in helping others. Yes, the teachings and initiations from high lamas can be extraordinary, but there's something in

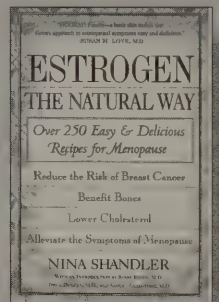


**Estrogen: The Natural Way**  
**Over 250 Easy & Delicious Recipes**  
**for Menopause**

Nina Shandler. 1998; 300 pp. \$14.95. Villard.

Is it possible to gain the benefits of hormone replacement therapy—to reduce the risk of osteoporosis and heart disease and alleviate hot flashes, insomnia, and other symptoms of menopause, while avoiding the potential risks associated with HRT, simply by eating certain foods? Phytoestrogens—naturally occurring plant estrogens—are known to do just that, but until Nina Shandler's book came along, it has seemed simpler in theory than practice.

While many studies have established that foods, particularly soy and flaxseed, are rich sources of naturally occurring estrogen, practical questions remain: How



much soy? How much flaxseed? How much does it take to alleviate hot flashes? How much to reverse the bone loss associated with osteoporosis? How much to lower cholesterol? And what do you do with flaxseed anyway? Shandler begins by outlining what is known about plant estrogens and menopause, then gives an easy-to-use system of daily portions of dietary estrogens. She first explains general principles for cooking with soy and flaxseed, then gives recipes that are both fun and accessible to those who lack the time or inclination to sculpt tofu. The recipes are quickly and easily prepared, low in fat, sugar, and calories, and remarkably delicious. —PP

of the wrathful female deities blazing throughout this global journey. We visit living women who have defied anger and despair to attempt practical solutions to enormous problems. Their voices are joined by historic, fabled, and literary ones, and the author's own, in a great outpouring of bravery and beauty. —Suzie Rashkis

me now that knows that indigenous traditions also need to be honored, and women's wisdom constitutes its own indigenous tradition of what it takes to make and sustain life. If we healed the wound between women, would mothers still sell their



## “ Lemon-Blueberry Pancakes

Work and Cooking Time: under 20 minutes. Equipment: electric blender.

Yield: Makes 2 generous servings.

Do your blueberries bleed? Do your pancakes come out purple? Does the extra blueberry juice invade the batter, making it too liquid? Mine did. Then I learned not to add the blueberries to the batter. Dust the blueberries with flour and put them on the pancakes as they cook. The juice will stay where it belongs—inside the blueberries.

1 1/2 cups plus 1 tablespoon unbleached white flour

1 teaspoon yellow miso

1 teaspoon baking soda

2 tablespoons lemon juice

1 teaspoon baking powder

2 tablespoons frozen apple juice

1 1/2 teaspoons grated lemon rind

2 cups soy milk

1/2 cup flaxseed

1 cup fresh or frozen blueberries

1. Heat a nonstick or oiled griddle or frying pan over medium heat.

2. Place the 1 1/2 cups of flour, baking soda, baking powder, and lemon rind in a medium-size mixing bowl. Stir until well combined.

3. Place the soy milk, miso, lemon juice, apple juice concentrate, and flaxseed in an electric blender. Blend until the seeds disintegrate and the mixture bubbles. Pour the liquid mixture into the dry ingredients. Stir until combined.

4. Place the blueberries in a small bowl. Add the tablespoon of flour. Toss, coating the blueberries.

5. Ladle the batter onto the preheated griddle or frying pan. Spoon a few blueberries onto each pancake as it cooks. Allow to cook until the surface bubbles and appears less liquid. Flip. Cook until lightly browned. Serve.

Plant estrogen estimate: 4 portions per serving.



## Under Wraps

Teresa MacInnes and Penny Wheelwright. 1987; 55-minute video, \$24.95 (\$30.45 postpaid). US orders: Great North International, 800/290-5482; Canada orders: National Film Board of Canada, 800/267-7710.

In classrooms around the world young girls learn about menstruation by watching cartoonish illustrations of female anatomy while disembodied narrators explain away the reality of blood. After viewing **Under**

**Wraps**, I long to see this video, the first film about menstruation not funded by menstrual product manufacturers, in the hands of every pre-pubescent girl. For women and men of any age, this is fascinating stuff. The filmmakers have gone beyond a feel-good reclaiming of natural cycles to explore the shame and taboo that surround menstruation and how this has served the menstrual marketeers.

Interviewing everyone in what they dub the “menstrual underground,” from artist Judy Chicago on her installation piece, *The Menstrual Bathroom*, to MacArthur Fellow



Margie Profet on the evolutionary biology of menstruation, **Under Wraps** is a fast-paced, well-edited documentary about the emotional, medical, and environmental impact of women’s monthly cycles.

As the enormity of the conspiracy of silence that surrounds menstruation slowly begins to emerge, the viewer realizes that it is our refusal to enter into a dialogue about menstruation that makes possible toxic shock syndrome, dioxin-laced tampons and beaches littered with plastic applicators. —Patricia Pettijohn [suggested by Jay Critchley.]

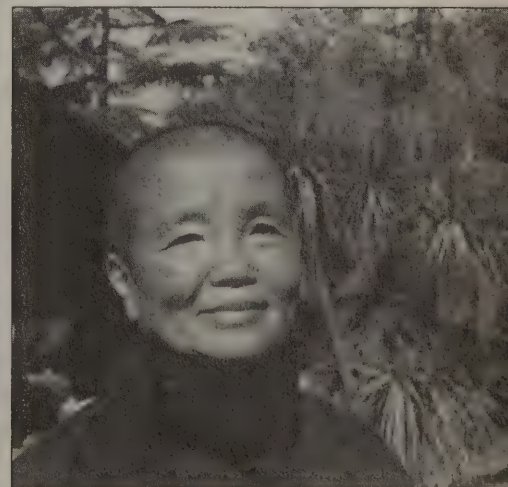
“ When I showed *Red Flag* at a conference in 1972, a Women and Arts Conference, I was just completely shocked by the reaction, because these women started booing me and hissing me in the audience, and shrieking at me, “How could you make an image of a bloody

penis?” and I was just astonished that they could not recognize something that many of them did every month, because *Red Flag* is a photo-litho based on a hand pulling a tampon out of the vagina. And they do it every month and had no mental image of it. —JUDY CHICAGO

daughters, their sons, their children? Could we stop the earth’s poisoning? There is no one answer, only fruitful directions. If women healed the wound between women, and men the wound between men, this indeed would be revolutionary.

Left: Laura Bonaparte, one of the Mothers of the Disappeared, wearing buttons showing her missing children and their spouses.

Right: Sister Chan Khong, a Buddhist nun, “grew ten thousand arms and twice that in Vietnam, starting to work with the poor as a teenager.”



Miss Tampon Liberty. Wearing his gown of 3,000 tampon applicators he found on beaches, artist Jay Critchley calls for a ban of plastic applicators in the documentary **Under Wraps**. Photo by Barbara Efthymiou.





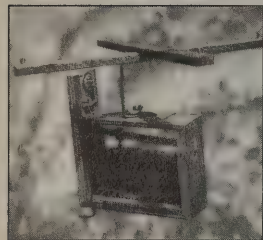
THE LOWDOWN ON THE HIGH UP

By Winslow Colwell

Kiters are a restless bunch. Always something new...or old. Here is some of what's keeping kiteniks looking skyward.

### Kite Aerial Photography

Well-known photos of the 1906 San Francisco earthquake were taken with (heavy) cameras mounted on (gargantuan) kites. Today KAP is more popular than ever. With current technology (small cameras with auto-wind, radio controllers) you'll be snapping photos from several hundred feet skyward with better results and more fun than ever.



Though primarily a hobby, there are practical applications to KAP that should not be overlooked.

Aerial photos of sensitive wetlands, or other areas that are not practical for low-flying air travel, can be useful tools. And artistic possibilities extend as high as your imagination; create some enormous crop art, then document with your kite camera!

Afficionados stay in touch and exchange ideas through their own magazine, the handsome **Aerial Eye**. Here you find plans for camera hangers, advice on the best kite models to haul everything upstairs, and an excellent gallery of photos from a bird's eye view.

To get up to shooting height, order the tech sheet written by **Aerial Eye** editor Brookes Leffler and available (free with SASE) from the **American Kitefliers Association** (the place to keep yourself in touch with all matters kitific). And be sure to check out Charles Benton's astonishing KAP website at <http://www.ced.berkeley.edu/~cris/kap/index.html>. Major inspiration.

### American Kitefliers Association

One-year membership \$25. 352 Hungerford Drive, Rockville MD 20850, aka@aka.kite.org, www.aka.kite.org.

Membership includes a subscription to the bimonthly *Kiting*.

### Aerial Eye

\$19/year (4 issues), \$14 for AKA members. PO Box 34, Pacific Grove, CA 93950, 408/647-8363, fax 408/647-8483.

All available back issues plus one-year subscription currently \$57.

### KiteLines

\$16/year (4 issues).

### Kite Traction

Again, not new. A Brit patented a kite-pulled carriage in 1823. But now speeds are higher than ever, and it's possible to travel pretty much where you please, rather than merely downwind. Sophisticated small catamarans pulled by kites are setting experimental wind-driven speed records on water, and there's all sorts of fun to be had on sand or your local salt flat or field.

Three-wheeled buggies are the vehicle of choice on land, and any manner of center-board craft is suitable for water. Power is supplied by maneuverable two-lined kites that are stacked to match the windspeed. There's thorough traction information at the **AKA** website at [www.aka.kite.org/traction.html](http://www.aka.kite.org/traction.html). In lieu of any book or magazine on the subject, order the brief yet concentrated **Buggies, Boats, & Peels** by New Zealand kite and buggy maker Peter Lynn. And reading **KiteLines** magazine will keep you up to speed on all the endeavors touched upon here. Plus, it's an impeccably written, full-color publication—the next best thing to being on the field!



### Indoor Kites

Indoor spaces will never replace your favorite meadow or beach. But, given enough headroom, new lightweight materials and intelligent design make it possible to ballroom dance with your kite. It's great fun. The models of choice for indoor competitors are made by GuildWorks or Buena Vista Kiteworks. The former, designed using the tensegrity principles of Bucky Fuller, are ingenious and beautiful objects, though be warned that the skills required to fly these tri- or quad-lined kites don't come easily.

### Buggies, Boats, and Peels State-of-the-Art Kite Traction & Owner's Manual

Peter Lynn. 1992; 15 pp. \$9.95 postpaid.

**KiteLines** and **Buggies, Boats and Peels** both available from KiteLines, PO Box 466, Randallstown, MD 21133, 410/922-1212, fax 410/922-4262, [kitelines@compuserve.com](mailto:kitelines@compuserve.com).

### Into the Wind

Free catalog. 1408 Pearl Street, Boulder CO 80302, 800/541-0314, fax 303/449-7315.

GuildWorks and Buena Vista Kites are both available from **Into the Wind**. Prices range from \$35 to \$330.



COREY JENSEN

### The Simple Science of Flight From Insects to Jumbo Jets

Henk Tennekes. 1998; 137 pp. \$25. The MIT Press.

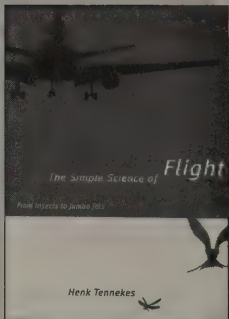
Right. Simple, eh? I picked this up with skepticism, and put it down hours later with my brain newly enriched. Tennekes does not shield his reader from the math, but instead presents the figures at a gentle pace and with such clarity as to render them comprehensible.

He examines the flight of birds, insects, and space shuttles with equal appreciation. The Gossamer Albatross is put into kinship with its namesake; the hummingbird and 747 are exposed as close cousins!

Slipped backward in time, this little book would have evaporated tears of frustration for da Vinci, Lilienthal, Bell, or the Wright Brothers. On the other hand, it would have kept Daedalus from making his escape, daunted by the need to collect enough feathers for wings, let's see, 180 feet across. —WC

“ At a speed of 560 miles per hour, the 747 uses 12,000 liters (3200 U.S. gallons) of fuel per hour—5.7 gallons per mile, or 0.18 mile per gallon. Your car may seem to do a lot better (perhaps 30 miles per gallon, or 0.033 gallon per mile), but the comparison is not fair. The 747 can seat up to 400 people, whereas your car has room for only four. What you should be comparing is fuel consumption per *passenger-mile*. A 747 with 350 people on board consumes 0.016 gallon per *passenger-mile*, no more than a car with two people in it....

Ten times as fast as an automobile, at comparable fuel costs: no other vehicle can top that kind of performance. But birds perform comparable feats. The English house martin migrates to South Africa each fall, the American chimney swift winters in Peru, and the Arctic tern flies from pole to pole twice a year. Birds can afford to cover these enormous distances because flying is a relatively economical way to travel far.



Top: Crop Art by Stan Herd, photo by Craig Wilson.

Above: An inexpensive KAP rig utilizing a one-use camera and wind-up timer.

Right top: Bugging on El Mirage Dry Lake.

Right: Synergy Zero Wind Great Deca by GuildWorks.



## Rethinking Tourism and Ecotrail

### The Paving of Paradise and What You Can Do to Stop It

Deborah McLaren. 1997; 182 pp. \$21.95 (\$26.45 postpaid). Kumarian Press, 14 Oakwood Avenue, West Hartford, CT 06119, 800/289-2664, fax 860/233-6072, www.kpbooks.com.

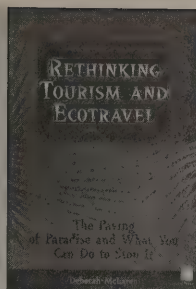
Deborah McLaren asks the most provocative question in travel today: Where is tourism traveling? And answers: down a dead-end path. She finds the problem is how transnational corporations "commodify" our urge to explore the world and how they coax us into excessive consumption even when it's the consumerist rat race we try to escape on vacation.

McLaren's analysis is persuasive though hardly new. In *The Golden Hordes* (1975), Louis Turner and John Ash, vanguard critics a generation ago, complained how tourism widens the North-South rift in the name of development. What McLaren adds is how ecotourism, which claims to balance conservation priorities of host societies with consumption priorities of the marketplace, further strengthens overseas control of the global enterprise. Ecotourists, same as their mainstream counterparts, fly mostly on airlines owned by transnational corporations. They inflate land values while competing with locals for onsite transportation and food. Their demand for everything from costly energy to lodge sites skews the allocation of scarce capital.

Further, the growing popularity of ecotourism subverts whatever integrity the idea of ecotourism once had. Marketers indiscriminately label everything "ecotourism." Not only the market gets confused. So do indigenous people dazzled by exposure to the purchasing power of ecotourists, no different from other tourists. Subsistence economies get subverted by the craving for cash.

McLaren, director of a nonprofit project that advocates local control over tourism, ultimately calls for basing all travel on respect for different ways of life. She argues that reform in tourism is impossible without first struggling against the consumerist grip on our own lives at home. McLaren's arguments rely chiefly on the critical writings of others instead of on first-hand familiarity with the places she wants to protect. This doesn't blunt her analysis but probably accounts for her narrow conclusion that only activism at home will prepare us for the activist role abroad that alone justifies traveling from here to there.

Meanwhile people keep traveling, and even those who accept McLaren's analysis will likely understand, in the way change comes slowly in all things, that ecotourism may be the best compromise on the way toward achieving that ideal world to which McLaren is dedicated. —Herb Hiller



“ Get involved in your own community so that when you travel you will have a reason to be involved in other communities and will stay involved; acknowledge the modern realities of Indigenous and rural communities and learn to respect, not romanticize, other cultures. Support responsible tourism organizations.... Pressure large tourism companies to do more than green-wash. Organize a “reality tour” of your own community to examine environmental, economic, or social justice issues. Invite teachers, students, local community members, your family, city officials, religious leaders, local businesses (including

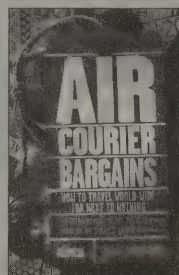
### Air Courier Bargains How to Travel World-Wide for Next to Nothing

Kelly Monaghan. 1997; 217 pp. \$14.95 (\$18.45 postpaid). The Intrepid Traveler, PO Box 438, New York, NY, 10034, 212/569-1081, fax 212/942-6687, info@intrepidtraveler.com.

The bargain is this: A shipper of expedited cargo can get it there much faster as a passenger's baggage than as air freight. You are the passenger. In return for carrying the paperwork—your only duty—you get a

“ The more likely scenario is that you and your companion will book flights on succeeding days. Companies that offer several flights a week are the most obvious choices. If they can swing it, they'll be more than happy to accommodate you. After all, they need to fill those seats....This strategy gives each person some time on their own at the destination

those in tourism) and others to participate. Make activism a goal of the tour. Contribute funds to support more integrated, diverse critical tourism studies.



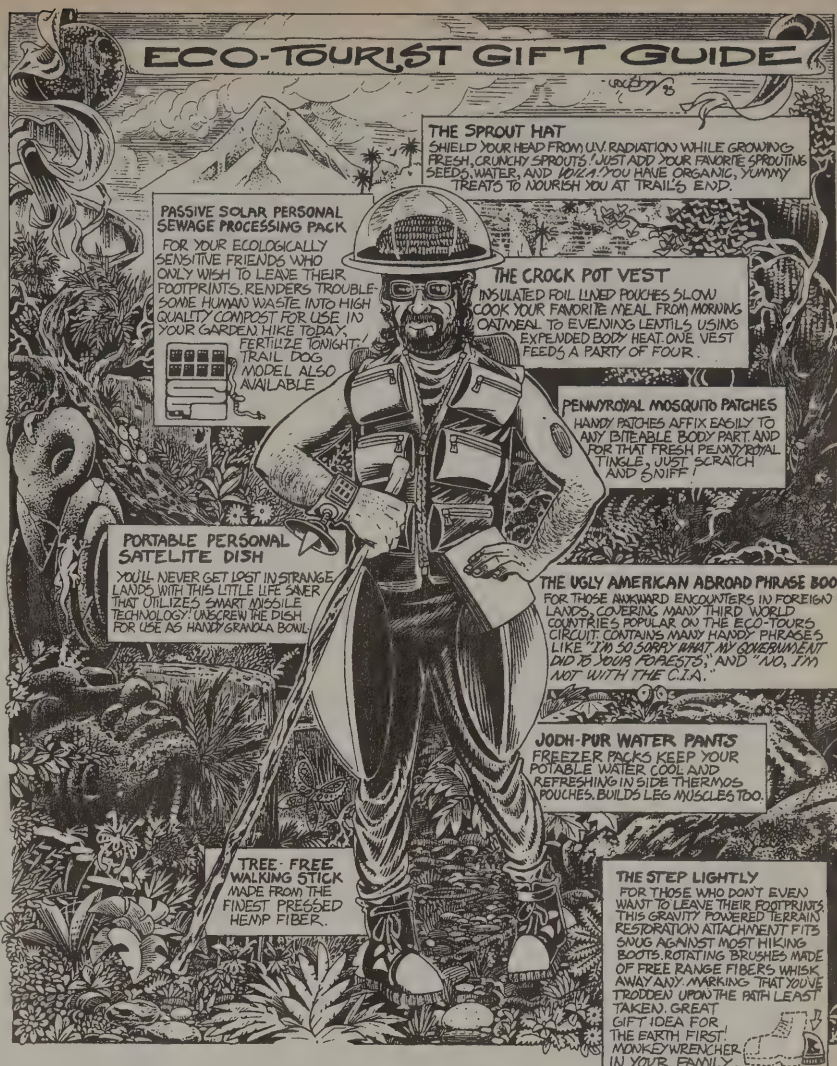
very good deal on airfare to a choice of interesting destinations. The catch? Singles over eighteen only. You typically fly last flight of the day, with only one item of carry-on luggage. Their choices of date are yours as well. In other words, it's cheap (typically twenty percent of regular fare) travel for individuals with simple needs, a flexible schedule, and a valid passport. This book tells all, even names and phone numbers. Tempting, no?

—J. Wingfoot Baldwin

to use as they see fit, without worrying about boring their companion.

“ The rigid length of stay requirements also means that you can forget about changing your return date.

“ Air courier travel, because of its very unpredictability, remains one of the few real adventures left in this age of homogenized travel.

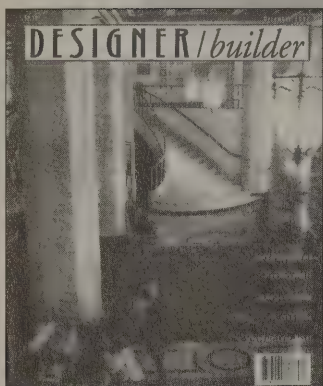


Cartoon by Vaughn, whom we haven't been able to find. Vaughn, please find us!





**DESIGNER/builder**  
A Journal of the Human Environment



Jerilou Hammett, editor. \$28/year (12 issues). 2405 Maclovía Lane, Santa Fe, NM 87505, phone/fax 505/471-4549.

This skinny magazine doesn't look like much, but every issue has something I've never seen or thought about before (this makes me

nervous). The editors consider architecture and building as an integral part of real, live culture—everyone's culture, whether you're cool, rich, workin' stiff, or on the dole. Entirely wonderful, even the ads. Available back issues will bring you up to date. —J. Baldwin

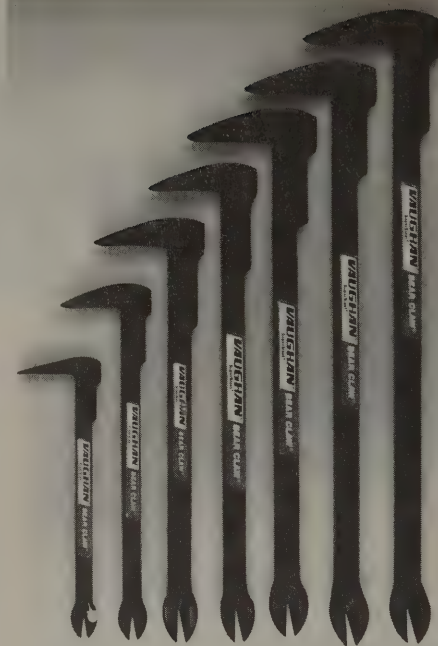
twenty-two shotgun-style houses to provide a public art project for African American artists, after-school programs, and a young mothers' program. Shotgun houses are part of the African American building tradition and its journey from West Africa to the United States. They are one room wide, several rooms deep, one story tall. They have no hallways, and the primary entrance is in the gable end. The term "shotgun" refers to the ability to shoot a bullet straight through from front to back without hitting any wall.

It was obviously deemed important by AMOCO and Home Depot, who came out with their employees to restore the exteriors.

Now the model is being exported to the Watts area of Los Angeles, and that's wonderful. I also found it a very aesthetically pleasing project. These were beautiful buildings, and in their simplicity they have beautiful proportions. It was quite wonderful the way the houses were arranged along an interior street, which bespoke a sense of community. And Project Row House didn't just restore one house to sit there as a museum piece. They restored and reestablished a community, and they didn't do it simply for financial gain.

Project Row House, Houston, Texas.

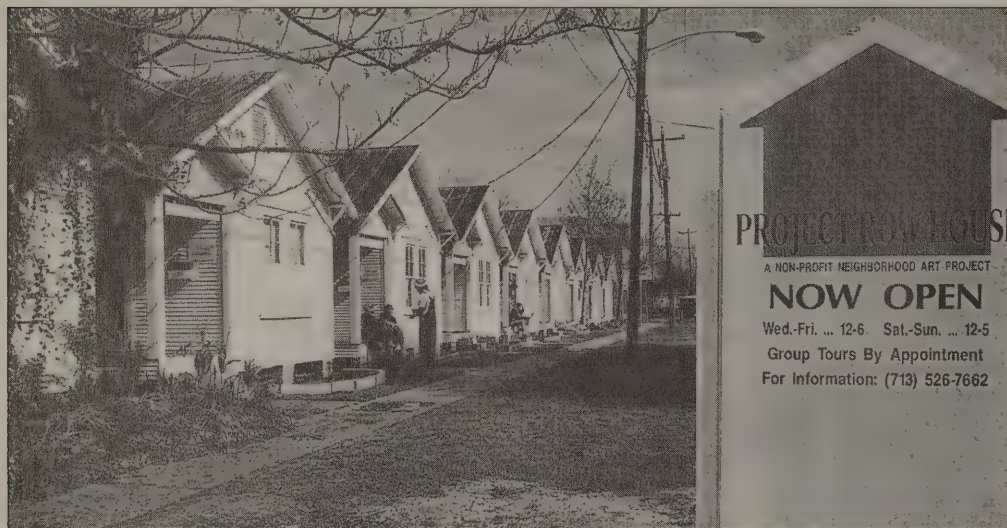
Project Row House, Houston, Texas, involved the rehabilitation of an abandoned, one-and-a-half block site of



**Bear Claw® Nail Pullers**

\$11-22 at hardware and building supply stores. Vaughn & Bushnell Manufacturing Company.

Patterned on a very successful and useful Japanese design, these nail pullers will yank the most stubborn foe with minimal damage to the wood. That's assuming, of course, that you've chosen the one of seven sizes that's juuuuuust right. Designed to be hammered upon. Sharp enough to catch headless nails. Vaughn is famous for using good steel. —JB

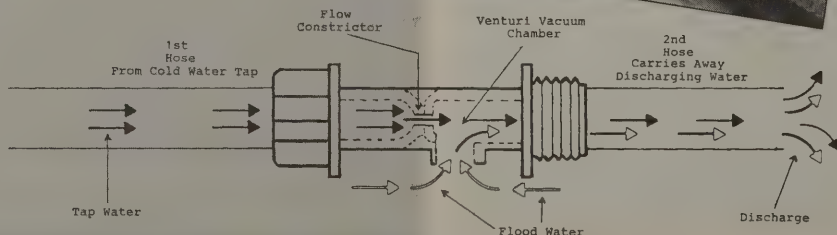
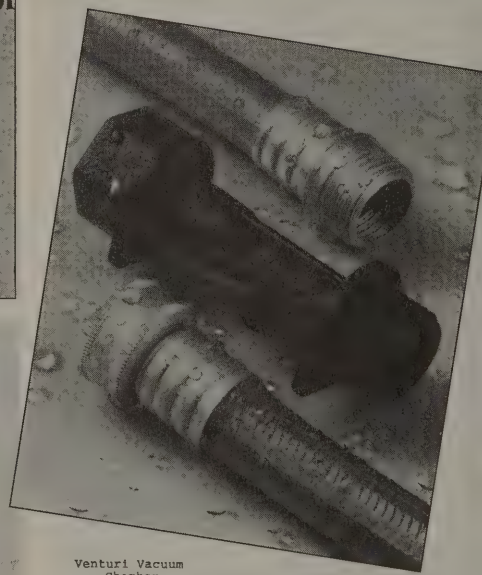


**Miracle Mini Pump**

\$11.95 includes shipping and handling. DesignLife Products, Inc. 1505 Old Deerfield Road, Highland Park, IL 60035, fax 847/266-7716.

It has no moving parts. It needs no motor. Yet it'll suck about 200 gallons of water per hour and spit it out through a garden hose to wherever (as long as it's not too high above the Mini Pump). It quickly drains the flooded cellar, garden pond, pool, or fountain. Cheap, too. Miracle? There must be a catch. There is. It's this: You must have a typical household pressurized water supply to make it

work, and the clean water leaves the premises along with the unwanted aqua being pumped. This device has been around for many decades. It works. Here's where to get one. —JB



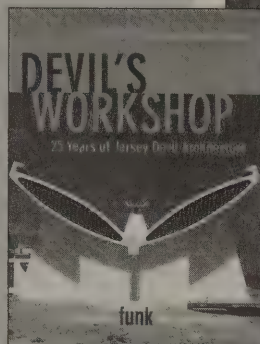


## Devil's Workshop

### 25 Years of Jersey Devil Architecture

Susan Piedmont-Palladino and Mark Alden Branch. 1997; 120 pp. \$29.95. Princeton Architectural Press. Distributed in US by Chronicle Books (\$33.45 postpaid), 800/722-6657.

The astonishing Jersey Devils (Steve Badanes, John Ringel, and Jim Adamson) hand-build what they design, and design as they build, adding method to their madness, so to speak. They live onsite for a while before deciding what sort of building should go there. They incorporate all manner of materials: natural, industrial, and whatever they happen to run across—one of their houses incorporates an Airstream trailer as a second-story guest room. Their striking, energy-efficient buildings celebrate the site, the climate, the client's inclinations, and the Devils' spirit. The author of this handsome book notes that, "As the former official magazine of the AIA, there is a certain irony to *Architecture's* decision to honor Jersey Devil with a cover, considering that their practice is composed of nonmembers who intentionally defied the AIA's policy on design-build activities..." I regard Jersey Devil architecture to be wonderfully relevant to our time. That's a rare attribute, in case you haven't noticed. —JB

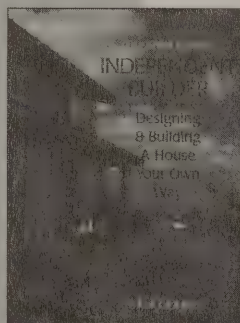


## The Real Goods Independent Builder

### Designing & Building a House Your Own Way

Sam Clark. 1996; 522 pp. \$30. Chelsea Green Publishing.

This is an up-to-date, straightforward manual for those brave folks hankering to design and build their own place. Technique is well covered, as you might expect—conventional architecture held together by friction and gravity hasn't changed much in the past 200 years. What's new and most welcome is a useful hit on basic design and structure, complete with those essential details so often missing in building manuals, e.g. how to design plumbing that won't freeze. An avuncular voice of wisdom and long experience is heard throughout. —JB

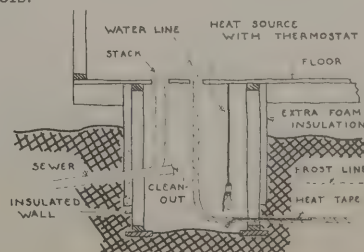


choices will influence your heat loss, and which efforts are worth it to you. As you look at superinsulation, Russian stoves, or solar panels, you can compare design and installation costs to fuel savings, and make the decision that works for you.

The formulas quantify a few basic ideas. Build a tight house, because drafts of any kind can account for a huge proportion of your heat loss. Make the house compact, because heat loss is proportional to surface area. Use lots of insulation, because insulation value, or resistance to heat loss, is proportional to the thickness of insulating material. Insulate everything. Put the big windows on the south, where the large heat loss will be offset by solar gain. Do everything you can to reduce the heat loss of the windows you do have, because windows lose much more heat than walls or roofs.

Palmetto House uses a radiant barrier to block up to ninety-five percent of the radiant heat gain: a foil barrier stapled to the outside of the wall and the roof frame reflects heat. The resulting hot air is vented out of the house through soffit vents, ridge vents, and wall vents. "The whole building basically breathes," says Jim Adamson.

“A heat loss calculation allows you to look at any version of your design, and figure the amount of heat you need for the heating season, the size of system you need, and what it will cost using different fuels. By mastering this bit of high-school algebra, you can figure how various design



A hotbox protects water lines where they enter the house.



Around the Florida Keys, Harold Hudson is known as "the Reef Doctor." He began as a fishery biologist in Florida, moved to the US Geological Survey, and is now a regional biologist for the Florida Keys National Marine Sanctuary in Key Largo.

Along with hands-on restoration work, he's been a pioneer in developing simple

## A CONVERSATION WITH THE REEF DOCTOR

technologies for complex problems. While at the USGS, he co-designed the first mooring buoys deployed in the Keys. A "miniature airlife respirator" he invented literally vacuums off the organism that causes Black Band disease in head corals. A primary focus these days is restoration of reef frameworks (ecostructures) severely compromised

by dredging and ship groundings. The work he describes here is financed largely by fines levied on the owners of boats that have damaged reefs.

The Doctor spends as much time as he can on rounds, tending to his patients. Managing Editor Michael Stone caught him during a dry-land stopover for this conversation.

**Michael Stone:** *What makes a healthy reef?*

**Harold Hudson:**

I want a reef to be aesthetically pleasing—to look good to the eye and to look natural. That draws divers and snorkelers, of course. But more than that, I'm convinced a reef's beauty is a sign of its health and fit within the ecosystem.

Stability, next. The reef needs to withstand strong wave and tidal forces. Reefs have tough outer shells; they're hard but brittle. Underneath the shell are sand, sediment, and rubble. A ship grounding opens wounds, exposing the vulnerable inner areas.

Then, three-dimensional complexity, to attract a complex array of life. A structure that shelters big predators, like fish, eels, and lobsters, but not the animals lower on the food chain, can't sustain itself. To attract the full array of life, you also need adequate height off the sea bottom. You want room for everyone in your hotel.

Height and complexity help reefs dissipate wave energy. Reefs protect coastal areas and sea grass beds from erosion. Sea grass meadows are the unsung heroes of the reef ecosystem. Their valuable habitats provide nursery areas and food for many reef inhabi-

tants. They photosynthesize. They trap and bind sediment, and act as water filters. But they can't withstand constant wave pounding, and need the reef to diffuse that energy.

**What are your chief restoration methods?**

When we can, we reattach or transplant coral with a lime-based Portland Type II cement. With a hydrating additive we developed, the cement sets in four to six minutes, so we can "spot weld" the attachments. After it sets, the cement is able to withstand forces of 3,500+ psi, secure against all but the largest storms. Some people have had success with epoxy, but I prefer cement. It's much less expensive and is made from calcium carbonate, just like the corals.

Whenever I can, I want to copy nature's patterns and materials.

**What if the coral is too damaged?**

In areas scarified by ships, coral is sometimes ground completely to powder.

For those places and for coral-impooverished reef areas, we've developed "reef replacement modules," half a meter to a meter and a half in diameter, that we cement to the bedrock. The method is analogous to a sculptor's lost wax technique, with sand, gravel, cement, and limestone rocks instead of wax for the interior mold. We pour concrete around the mold. When it sets, we wash the sand mixture out, leaving a beautiful interior complexity, with caves and voids, that provides safety and refuge and a place to multiply, not only for large predators, but for all the animals down the food chain.

Diver Joe Fuhr transplants a mountainous star coral, displaced by the grounded freighter *Wellwood*. PHOTO: HAROLD HUDSON.

# HELPING NATURE HEAL



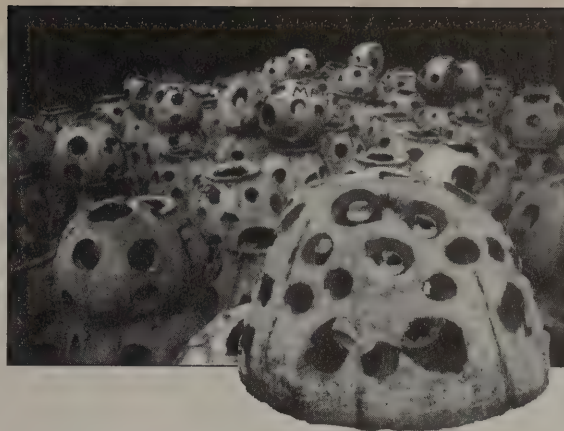
We built one patch of reef in Biscayne National Monument, cementing eleven species of hard corals and ten species of soft corals to the modules. Ten years later, twenty-eight of thirty-two hard-coral transplants were alive and healthy. Maybe more important, 134 new hard and soft corals, comprising twenty-two species, had settled on the domes. A fish census found an average number and species diversity intermediate between that of a nearby patch of natural reef and that of an adjacent area of sea floor.

### What about artificial reefs?

You see I have a strong bias toward concrete. It's a proven product, using mother nature's methods. The results are very solid, very durable. A reef we built in 1977 withstood the eye of Hurricane Andrew. It blends in, creating as natural a reef as possible.

Some other methods are designed to create "instant reefs" to attract fish and other animals (and divers, tourists, and fishing boats). People have tried to build reefs out of piles of loose rocks, cars, tires, sunken airplanes. They weren't stable. They deteriorated quickly. Storms pushed them onto the living coral reefs.

Sinking ships is a popular way to mimic reefs. They do attract large predators, and create exciting environments for divers. As far as I can tell, though, they don't attract many of the animals farther down the food chain. They're covered with paint that flakes off over time. The iron ultimately turns to iron oxide, and the structure deteriorates. At that point, I guess you sink another ship. In the meantime, hurricanes can destroy ship "reefs" so they migrate onto living reefs in storms. Since algae need iron to reproduce, it's possible that sunken ships may also encourage algae growth, though I don't think that's been demonstrated.



Reef Ball. For more information: Reef Ball Development Group, PO Box 3349, Bradenton, FL 34207, 941/752-0169.

The jury is still out on whether artificial reefs build habitats that yield new life, or just concentrate life by attracting fish from other locations.

Concrete walls as coastal protection are prohibited in Florida and some other places. They create some vertical stabilization, but allow tremendous wave energy to build up outside the wall, churning up the ocean floor.

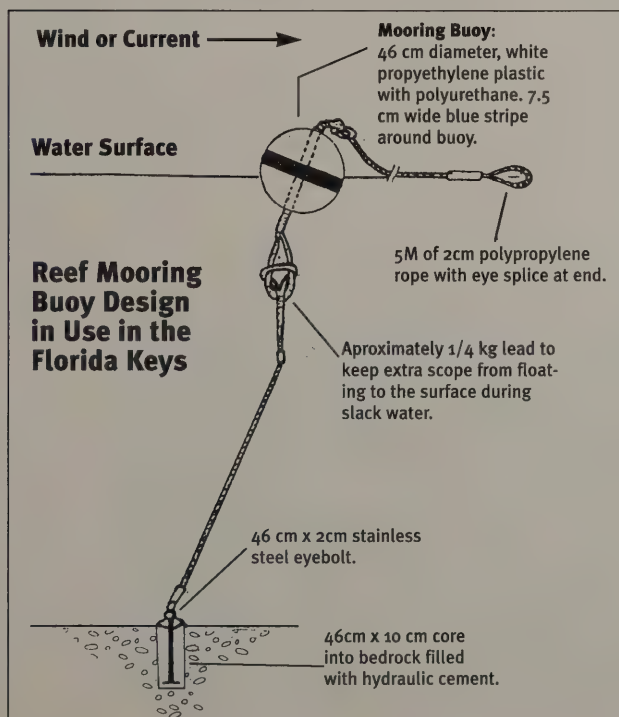
"Reef Balls" have demonstrated some utility in low-energy areas. They're made by pouring concrete into a fiberglass mold in which a bladder is inflated, with plastic balls inserted to create windows. They're placed in deeper water, in hopes that they'll be colonized by barnacles and then coral. Their virtue is that they're light—they can be floated with the bladders inflated and deployed without heavy machinery. Those I have seen are smooth, open structures, without the complexity to shelter small organisms. I saw some in the Bahamas. Nothing was growing on them. The ones I've seen are not secured to the substrate; unless they can be firmly attached, I'm afraid storms will roll them onto coral and other organisms.

So far, I'm withholding judgment on mineral accretion technology. Tom Goreau and Wolf Hilbertz have developed an intriguing process that bears watching. It could be a really neat thing. At this point, it still needs refinement. There are built-in problems: the installations need monitoring, and require an application of current. They're restricted to the shape of the armature; I'd like to see them be more pleasing to the eye. I also wonder whether they'll be truly durable. But I'm interested to see how they develop.

### What's the long-term perspective on your work?

Coral grows about half an inch a year. I'm going to retire before a coral I start is two feet high. It's like waiting for a redwood to get big. You have to think about starting work that isn't going to be completed in your lifetime. But you can also make a short-term difference. A surviving pillar or toppled colony would need fifty years to attain a height of three feet. By reattaching and "jump-starting" an old-growth stand of pillar coral, you can save that much time, improve the reef's chances of recovering, and help ensure that its beauty will be there long after you've left it. ⊕

Mooring buoys provided at no cost by Reef Relief and the Florida Keys National Marine Sanctuary eliminate the need to drop anchor on living coral.





# Coral Reef Resources

## Reef Relief

\$20 annual membership includes subscription to the quarterly Reef Line. PO Box 430, Key West, FL 33040, 305/294-3100, fax 305/293-9515, reef@bellsouth.net, www.reefrelief.org/library.html.

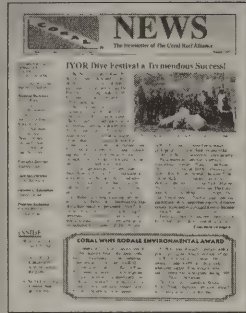
Reef Relief began in 1986 as the first private effort to deploy mooring buoys to stop boaters' dropping anchor near reefs (see illustration, p. 87). Since then, it's added education, advocacy, and community organizing to its repertoire. It produces brochures and signage in six languages with "basic principles for visiting our reefs" for tourists, divers, boats, and hotels. Among its legislative achievements: creation of the Florida Keys National Marine Sanctuary; a ten-year federal ban on offshore oil leases in the Keys; cancellation of US Navy ordnance testing in reef areas; upgrading state rules for sewage pumping; a county ordinance (and voluntary agreements from hotels) to limit phosphate use.

Reef Relief directs a photo survey to collect baseline images and monitor changes in the coral community. By comparing the same coral heads over time, the survey is providing scientists with the first documentation of the spread of several coral diseases in the Keys. This spring, Reef Relief merged with its California counterpart, Coral Forest (best known for its Grateful Dead linkage), with Bob Weir, Wendy Weir, and Rainforest Action Network's Randy Hayes joining the board.

## CORAL: The Coral Reef Alliance

\$25 annual membership includes quarterly CORAL News. 64 Shattuck Square, Suite 220, Berkeley, CA 94704, 510/848-0110, fax 510/848-3720, CORALmail@aol.com, www.coral.com.

CORAL mobilizes divers to fight threats to coral reefs. It provides funding and technical support to help local communities put out mooring buoys and set up their own Marine Protected Areas. Divers file reports, via



CORAL's website, on the condition of reefs they visit, to be forwarded to scientists and activists. It publishes a Checklist for Sustainable Diving in Coral Reef Areas for divers, operators, and resorts. CORAL led the efforts to expand the 1997 International Year of the Reef from a modest scientific initiative into a public awareness campaign involving more than 1,000 organizations.

## The Coral Reef NGO Directory

http://coral.cea.edu/NGO/Contents.html.

Looking for a coral reef organization close to home? Here's access to 178 coral reef organizations in forty-seven countries.

## Ocean Voice International

\$25 (Canada\$ for Canadians, US\$ for others, one-half regular fee in developing countries) includes quarterly Sea Wind. 3332 McCarthy Road, Ottawa, Ontario, K1V 0W0, Canada, fax 613/521-4205, mccall@superaje.com, www.oivi.ca.

OVI is a leader in the international effort to stop practices like using explosives to capture food fishes

and spraying sodium cyanide on coral heads to stun and capture aquarium fishes. OVI has trained 700 aquarium fish harvesters in coral-friendly techniques and joins NGO partners for sustainable and equitable marine harvesting. OVI also manages the IUCN-World Conservation Union's ongoing GIS analysis of the state of the world's coral reef fishes.

## Reef Check

http://www.ust.hk/~webrc/ReefCheck/reef.html.

Reef Check's leaders call it "a volunteer program, not an organization." In 1997, 750 sport divers and 100 scientists completed a one-time survey of more than 300 reefs in thirty-one countries. They found, they say, "the first solid evidence that coral reefs have been damaged on a global basis," and decided to make the survey a yearly event. It's based at the Institute for Environment and Sustainable Development at the Hong Kong University of Science and Technology, with regional coordinators in eleven countries. See their website for contacts in local areas.

## Collaborative and Community-Based Management of Coral Reefs

Alan T. White, Lynn Zeitlin Hale, Yves Renard, and Lafcadio Cortesi, eds. 1994; 130 pp. \$21.95 (\$26.45 post-paid). Kumarian Press, 14 Oakwood Avenue, West Hartford, CT 06119, 800/289-2664, fax 860/233-6072, www.kpbooks.com.

A non-technical book. Top-down mandates have failed to protect reefs, especially in subsistence economies. Here are success stories from bottom-up projects (involving, for instance, not only aquarium-fish gatherers, but their families, community officials,

local NGOs, and the rest of the buyer-middleman-exporter-purchaser chain). Stories of hope in Indonesia, the Philippines, Thailand, the eastern Caribbean, and Florida.

## State of the Reefs: Regional and Global Perspectives

Stephen C. Jameson, John W. McManus, and Mark D. Spalding. 1995; (hard copy out of print). http://www.ogp.noaa.gov/misc/coral/sor/sor\_contents.html#toc.

Other introductions largely ignore regional differences. State is the bioregional best (Tropical America, the Middle East, the Indian Ocean, East Asia, the Pacific).

## Reefs at Risk:

### A Programme of Action

Bernard Salvant, ed. 1993; 24 pp. £4, US\$6. Global Climate Change and Coral Reefs: Implications for People and Reefs Clive Wilkinson and Robert Buddemeier. 1994; 124 pp. £10, US\$15. Both from IUCN Publications, Fax: + 44 1223 277175, email: iucn-psu@wcmc.org.uk, http://www.iucn.org.

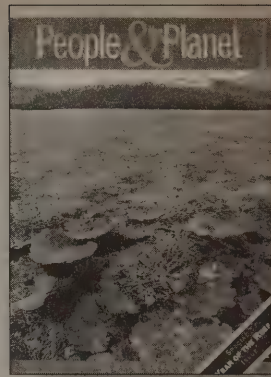
Add 20% for surface mail, 40% for airmail.

Reefs at Risk announces the new factor of global climate change—everything from coral bleaching from temperature-induced stress to water acidity to impacts after sea levels rise—issues that receive scant treatment elsewhere. Global Climate Change takes up the theme in depth.

## People & the Planet

Vol. 6 No. 2. £2, \$4 overseas. 1 Woburn Walk, London WC1H 0JJ, UK., + 44 (0) 171 383 4388, fax + 44 (0) 171 388 2398.

Excellent, comprehensive issue on coral reefs in crisis, with attention to worldwide



conservation efforts. Some articles are on website: www.oneworld.org/patp/.

## Free Poster-Sized Coral Reef Map

Denise O'Brien, Group ESH Administrative Officer, BHP Petroleum, 20/120 Collins Street, Melbourne, Vic 3000, Australia, O'Brien.Denise.DM@bhp.com.au (email preferred).

## The Life and Death of Coral Reefs

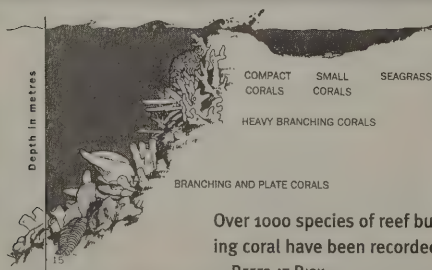
Charles Birkeland, ed. 1997; Chapman and Hall. Out of Print.

Highly recommended by our coral-expert consultants. Check your library or beat your flippers to bring it back into print. Also see Elsevier's Coral Reefs (Volume 25 of Ecosystems of the World, 550 pages). Spectacular info, spectacular cost (about \$175).

## Selected Guidelines, Handbooks and "Tools" for Coral Reef Management

http://coral.aoml.noaa.gov/themes/tools.html.

For the comprehensive technical info, the University of Rhode Island, USAID, and World Wildlife Fund International compiled this twenty-screenful annotated list.



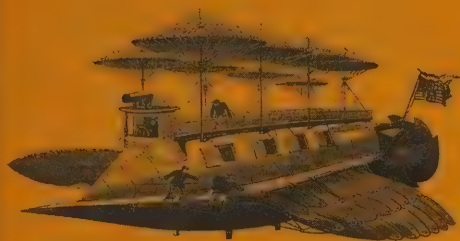
Over 1000 species of reef building coral have been recorded —REEFS AT RISK



Brain coral at Curacao in the Netherlands Antilles. —REEFS AT RISK



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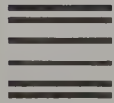
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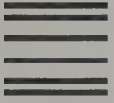
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## Electrically Charged Reef Restoration

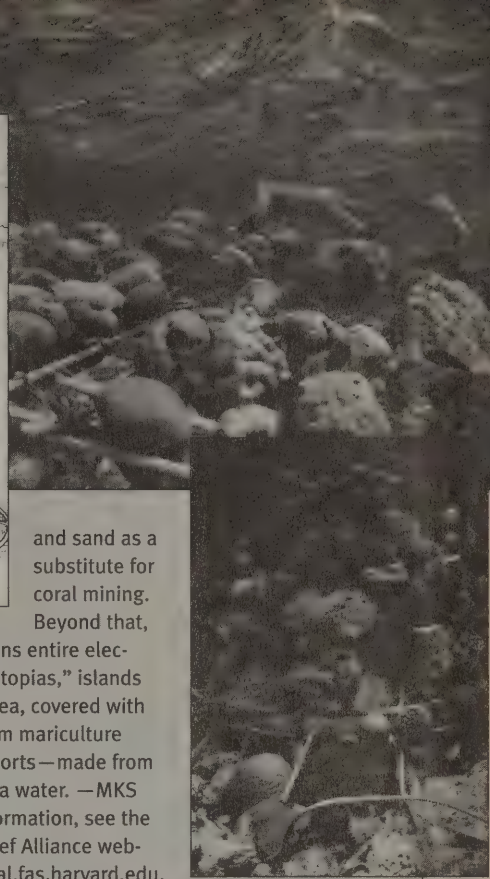
German architect Wolf Hilbertz began experimenting with mineral accretion in 1974, and is developing it commercially in partnership with Tom Goreau of the Global Coral Reef Alliance. A direct current between electrodes in sea water or brine precipitates calcium carbonate (limestone) at the cathode. With a current as low as three to four volts, they've achieved limestone precipitations of one to two cm a year, to which they cement coral. The limestone provides a base for the coral, and, in Goreau's words, "the current gives the coral a chemical boost and frees up energy to outcompete the weeds," stimulating reef growth in areas where poor water quality is killing surrounding coral. They employ solar panels where possible, and are researching turbines powered by tidal action.

The technique seems not to work in places like the Mississippi Gulf where fresh water dilutes the ocean's calcium content. Early prototypes were destroyed by storms. Hilbertz believes that an installation will be able to withstand hurricane-force winds after six to nine months. Their longest currently operating structure, built in the Maldives in 1996, has stood up to monsoon winds. They could

cut off the current now, says Hilbertz, but they want to keep monitoring the accelerated growth rates.

The cost of a break-water framework they began last year in the Maldives is running at less than one-fiftieth the cost of a concrete seawall built on Male, the capital island, after disastrous storms in 1987. They believe the final cost will be no more than one-tenth the cost of the seawall.

Their dreams extend well past reef restoration. They see solar and tidal power, combined with the ocean ("the world's largest continuous ore-carrying body"), as a major basis for infrastructure that doesn't require earth mining or fossil fuels—and, in fact, creates a carbon sink. They are now testing "solar bricks" of pulverized mineral accretion



and sand as a substitute for coral mining. Beyond that,

Hilbertz envisions entire electroaccreted "Autopias," islands built from the sea, covered with structures—from mariculture facilities to airports—made from sunlight and sea water. —MKS

For more information, see the Global Coral Reef Alliance website: <http://coral.fas.harvard.edu>.

### How Many Ways are There to Damage Coral Reefs?

#### Natural (or abetted by human influences):

- ✓ Hurricanes
- ✓ El Niño
- ✓ Global warming

#### Human:

- ✓ Touching with hands and feet
- ✓ Boat anchors and propellers
- ✓ Ship groundings and leakages
- ✓ Aquarium harvesting
- ✓ Curio harvesting of corals and shells
- ✓ Fishing by explosives
- ✓ Fishing by cyanide and other poisoning
- ✓ Fishing by muro-ami and kayaka (frightening fish by hammering coral)
- ✓ Mining for construction bricks
- ✓ Mining for lime manufacture for mortar and plaster and fertilizers
- ✓ Solid waste dumping
- ✓ Nutrient pollution from ag runoff
- ✓ Nutrient pollution from nearshore sewage outfalls and storm runoff
- ✓ Toxic pollution from industrial outfalls and agrochemicals
- ✓ Toxics and nutrients from boat discharges
- ✓ Oil spills from platforms and transport
- ✓ Siltation from upstream deforestation, dams and irrigation projects
- ✓ Siltation from nearshore dredge and fills

—MKS

### Beneath the Sea in 3-D

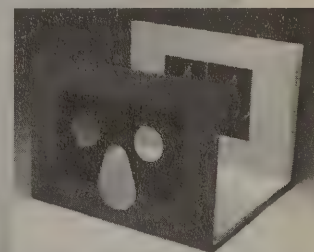
Mark Blum. 1997; 96 pp. \$18.95. Chronicle Books.

OK, this book doesn't focus on coral reefs, but it's way too much fun to leave out. Turn to one of its stereographs, flip down the attached viewer, and *voilà*, you're staring down a Nassau Grouper's gullet or picking out a Coney hidden in Elephant Ear Sponge. There's enough text to convince yourself that this is educational. You'll keep coming back, though, for the best rush of underwater beauty to be had on dry land.

—MKS



Christmas Tree Worm, in 2-D.





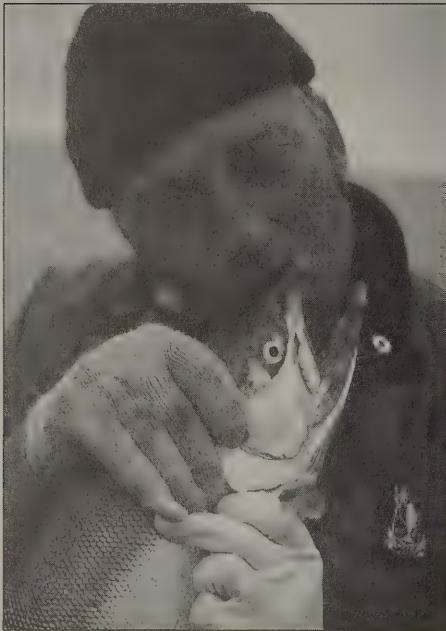


**Faces of Fishing**  
 People, Food and the  
 Sea at the Beginning  
 of the Twenty-First  
 Century

Bradford Matsen.  
 1998; 120 pp. \$19.95.  
 Monterey Bay  
 Aquarium Press,  
 408/648-4952.

An outgrowth of the Monterey Bay Aquarium's recent exhibition, "Fishing for Solutions," **Faces of Fishing** documents the deteriorating state of the world's fisheries through photography and a text that's written from the inside-out. An editor-at-large at *National Fisherman*, Bradford Matsen has spent seventeen years aboard shrimpers, trawlers, and long-liners and has witnessed firsthand the depletion of the planet's oceanic

Pete Blackwell kisses his first salmon of the Bristol Bay season before throwing it back.



Below, Tuna, Tsukiji Market, Tokyo.  
 —FACES OF FISHING.

resources. There is nothing, he reports, that is mysterious about the causes: over-fishing, by-catch, coastal habitat destruction, and human population growth. What is mysterious is that we continue to allow our fisheries to decline in the face of so much evidence.

The archival-quality photography accompanying Matsen's clear-eyed, forceful text provides poignant imagery of fishermen at work, and in this sense **Faces of Fishing** is, despite all the bad news, ultimately a celebration. Significantly, these contradictory nuances are at the heart of Matsen's message. Fishing has always been rooted in community, and when practiced responsibly it provides perhaps our best model of sustainable development. There's a timeless quality to the photos—a man and his wife cleaning their catch of stingray on a beach in Baja, a kiss for the first salmon of the season, fishermen mending their nets in Morocco. Juxtaposed with these tableaux are immensely depressing images of factory ships and a gigantic market morgue for mega-bucks tuna in Tokyo. This book is a cry for restoring humankind to the face of fishing through sensible policy, sensible practice. —Allston James

“ Nearly half the seafood in the world comes from those small-scale coastal fisheries, but is consumed by people who eat it within a few miles of the beach or dock where it came ashore. The people who depend on that food are much more closely connected to its source. If they overfish, they know about it quickly and either figure out how to fish sustainably or miss a lot of meals. The feedback loop connecting irresponsible fishing with deprivation or death is local, a matter of concern for the entire community and not just the people doing the actual fishing.

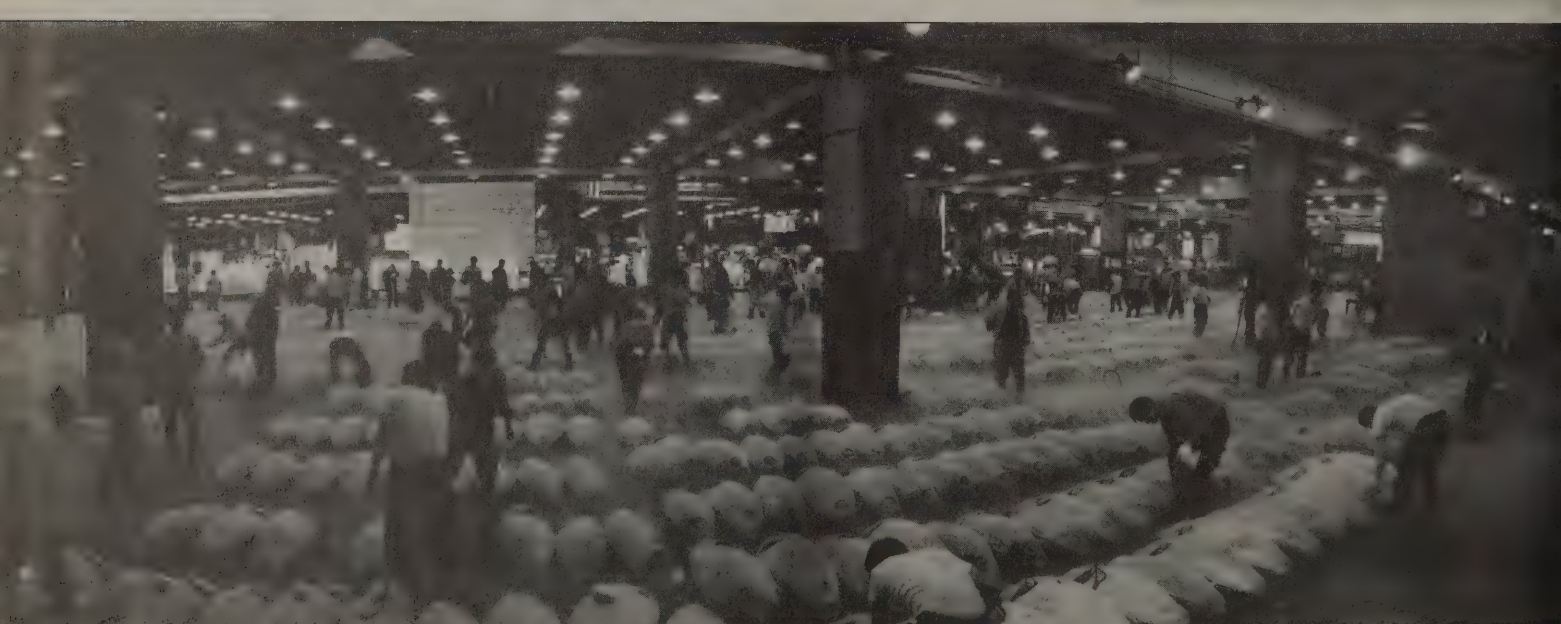
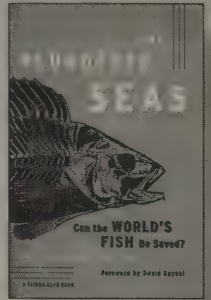
**The Plundered Seas**  
 Can the World's Fish Be Saved?

Michael Berrill. 1997; 208 pp. \$22.50.  
 Sierra Club Books.

The answer? A super-equivocal maybe. This book is as concise and readable an overview of our global fisheries and their collapse as you'll find.

Biologist Michael Berrill has written a comprehensive, crisp-paced history of the planet's fisheries. He explains how they have been systematically brought to ruin, walking us through the often arcane territory of management issues and international economics with authority and verve. (You have to like a writer whose choice of epigraphs includes Shakespeare and the *Joy of Cooking* on the same page.)

With one billion people relying on fish as their primary source of animal protein, he reports, something has to give. Before outlining solutions, Berrill succinctly catalogs the fifth largest agricultural commodity on Earth with profiles of the collapsed cod fishery on the Grand Banks and other imperiled waters, highlighting the twisted knot of problems—overfishing, damaged habitats, destructive gear, mindless waste, all topped off with unbridled levels of international greed. In 1985, in the North Sea alone, trawlers took 500 million haddock but discarded 460 million fish, dead after the sorting, that were too small or of the wrong species. So, where's the hope? The author feels the 1982 Law of the Sea that





was ratified by enough nations to become international law in 1994 may help reverse the tide.

According to **The Plundered Seas**, the good news is that our choices are clear ones: lower catch quotas, reduce fleet sizes, reduce by-catch, recover coastal habitats, and start accepting responsibility for our seas. The bad news is that we may lack the guts to make these choices. —AJ



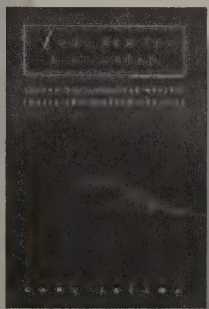
Both Canada and the United States took control of very large Exclusive Economic Zones, but the United States did particularly well because of its island possessions from the Aleutians to Hawaii and on into the South Pacific. (Islands that extended a country's jurisdiction did have to be habitable, which led to attempts at inhabiting some quite uninhabitable rocks or islets.) Other countries, with extended distant-water fleets but short coastlines of their own, became instant losers.

“The new Law of the Sea allows each coastal country to manage its fisheries, setting the total amount of fish of any species that may be caught; to propose appropriate management and conservation programs; to promote optimal use of the fish resources, which often means allowing other countries to fish for any surplus in return for fishery-related benefits such as access fees. These are not easy responsibilities, and they remain full of the uncertainties that have pushed fish populations into decline in the days before EEZs [Exclusive Economic Zones] existed. Who knows what the optimal use of a fish resource is? And access fees can be very tempting for those countries lacking the ability to overfish their own resources without outside help.

**Song For The Blue Ocean Encounters Along the World's Coasts and Beneath the Seas**

Carl Safina. 1997; 458 pp. \$30. Henry Holt.

About twenty pages into this book you may discover that you are not so much reading it as savoring it. A scientist who has been active in American oceans policy on a wide front (founder of the Living Oceans Program at the National Audubon Society, member of the Mid-Atlantic Fisheries Management Council), Carl Safina has melded hard science and romantic vision into a full-blown portrait of our ocean planet. It is a book about fish, people, and policy that moves like a current from the Gulf of Maine to the Pacific Northwest's Yaquina Head and Columbia Gorge, then winds its way through the blue expanse of the Far Pacific.



What distinguishes the text is not only Safina's informed candor but the voices of the fishermen who don't always share his conclusions that the world's oceans are essentially being murdered. Whether discussing long-lining on the Georges Bank or cyanide fishing in the Philippines, Dr. Safina, adjunct professor at Yale University, brings in the experts, be they national policy advisors or local reef fishermen. He is that rarest of writers—he knows how and when to get out of the way of his own story. —AJ

“One bluefin tuna recently sold for \$83,500, nearly \$117 per pound. The 715-pound giant was to be reduced to 2,400 servings of sushi, which, because of the exceptional quality of this individual fish, would be served to elite businessmen and government officials for \$75 per serving, bringing in, altogether, an estimated \$180,000. One fish.

“Around the year 1500, explorer John Cabot had described the Grand Banks as so “swarming with fish [that they] could be taken not only with a net but in baskets let down with a stone.” Within seventy-five years, the fish were supporting a boom. One colonist noted that the cod “draweth many nations thither and is become the most famous fishing of the world.” Now it is famous for another reason. Where was once a natural system of unimaginable richness, spurring the colonization and prosperity of northeastern North America, there is now a \$2 billion welfare burden and 60 percent unemployment. To people whose families have lived in the region for centuries, it is an apocalyptic transformation.

“Even worse than the fish it kills, cyanide—as fishers who use it will invariably tell you—kills the corals. Laboratory tests show cyanide can be fatal to corals at concentrations *two hundred thousand times lower* than those found in the fishermen's squirt bottles. Within seconds of exposure, coral polyps begin emitting a thick mucus, trying to purge the irritation. After a few hours the mucus disappears, and all seems well. A few weeks later, the corals are dead, their skeletons bright white. Because big coral heads can be several hundred years old, we can expect to see living corals of this size again no earlier than the year 2300, if recovery begins immediately. In geological time, that's not very long, but for us as persons, it's greater than forever.

“Bluefins' [schooling] parabolas serve two functions. One, they provide significant energy savings from easier swimming. With their pectoral fins outstretched, the bluefins take advantage of the lift generated by their neighbors (similar to geese flying in formation); they can also gain increased thrust without increasing effort by “pushing off” of the compaction of water against each other. Second, and more importantly, the parabola formation functions as a dragnet, allowing the bluefins to corral and envelop prey schools they encounter as they travel.





## Making Faces Using Forensic and Archaeological Evidence

John Prag and Richard Neave. 1997; 256 pp. \$39.95. Texas A&M University Press.



A hundred years ago, when Heinrich Schliemann first discovered the golden death masks in the Bronze Age graves at Mycenae, he is supposed to have sent a telegram to the King of Greece: "I have gazed upon the face of Agamemnon." According to John Prag, this is a dramatization of Schliemann's actual report; and although the graves at Mycenae were dug several centuries before

Agamemnon could have been born, the story continues to thrill introductory archaeology classes all over the world. In **Making Faces**, Prag and Richard Neave go one better than Schliemann by showing us the actual faces of the people who were buried there.

The two men, an archaeologist and a medical artist, use techniques developed by forensic investigators to reconstruct faces from skeletal remains. Prag calls these models three-dimensional research reports. The ultimate goal of the work is to animate the past, whether it is ancient Egypt or Bronze Age England. Each chapter is a detective story in which all the information known about the skeletons and their cultures is gathered together to create an exhibit that gives people an authentic connection with history. **Making Faces** reminds us that archaeology is the study of people, not the study of artifacts. —Sheelagh Frame

## When the Land Was Young Reflections on American Archaeology

Sharman Apt Russell. 1996; 230 pp. \$23. Addison-Wesley.

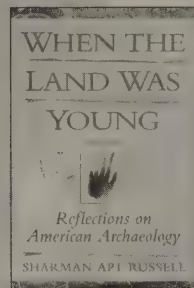
Sharman Russell has crafted an engaging, pleasurable introduction to some of the most compelling issues being tackled by North American archaeologists. Who were the first Americans and when did they come? How can we construct the long-neglected realm of women's roles in the past, and how do women fit now, within the realm of contemporary archaeology? What are the politics, ethics, and matters of spirituality involved in studying Indians and their ancestors' remains? Russell addresses these questions with a refreshing honesty and evenhandedness founded on solid research.

Each chapter reads as an independent story, one in a series of her personal forays into the past. She also delves into the minds and lives of dynamic men and women grappling with the construction and stewardship of our country's heritage. Russell places herself firmly in the picture, as mother, as middle-aged woman, as not only a professional scientist, but also a person with a deep attachment to the land. Her awe of the past's mysteries is palpable, and her enthusiasm is infectious.

—Heather Price

To borrow the word of archaeologist Robin Fox, this is a "paleoterrific" read.

—ET



palmettos, they wove cloth. From stone, wood, and bone, they made tools. Children often died young, but adults frequently lived into their seventies. People took care of each other. When one older woman injured her shoulder and arm, a relative or friend nursed her until she was well.

A boy had crippling spina bifida; the tribe provided for him until his death from infection at the age of fifteen. Arthritis plagued them, as did gum disease. Still, on the whole, these were people who ate well, loved well, lived well.

When someone died, he or she was wrapped in cloth and buried with things we call artifacts...taken quickly to a nearby marsh, placed in a grave of muck, and pinned there by long sharpened stakes. The mineralized water was only slightly acidic. The wet peat prevented further decay. Seven thousand years later the bodies in this ancient cemetery are remarkably preserved....Today residents of the Windover housing development bicycle and jog on the narrow road that runs past the pond and sandy hammock. Saw grasses cut the air. Herons glide discreetly. Oak, pine, and cabbage palmetto fill the interstices between the houses. A motor starts up. A boy's voice rises and falls and stops abruptly. This is a quiet suburb, with its own secret dramas.

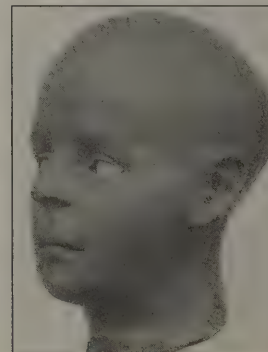
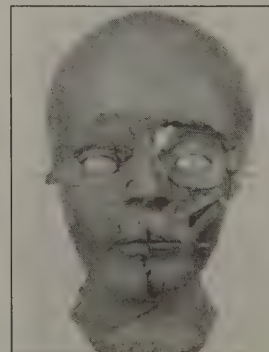
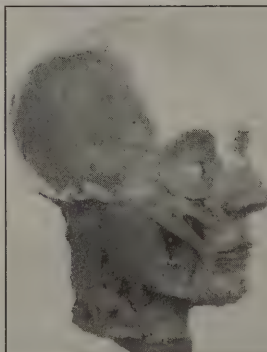
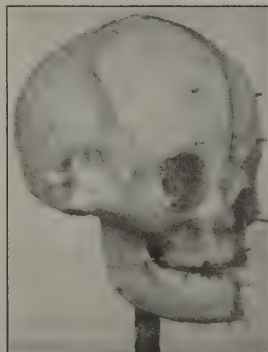
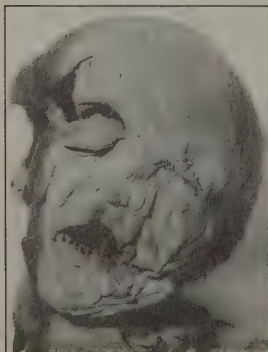
“The...question is like hitting a bruise, the pain of our post-industrial angst. Was it better? In the last two centuries we have had small but diverse groups of hunters and gatherers to study. Some had lots of leisure time; some didn't. Some starved on occasion, some hardly ever. Much depended on the physical environment. Still, this doesn't touch the heart of the question, which is about spirit not matter. Was it better emotionally? Were we better? Were we more alive, more human, more engaged?...We'll never know....Archeology reminds us that what we are doing today, right now, is a tiny sliver of the human experience.

“They lived near the coast of eastern Florida between 7,000 and 8,000 years ago, or 5000 to 6000 B.C. Small game was plentiful. Plants, too, were important: hickory nuts, acorns, persimmon, elderberry, grape, prickly pear, cherries, plums, and roots. From the fiber of

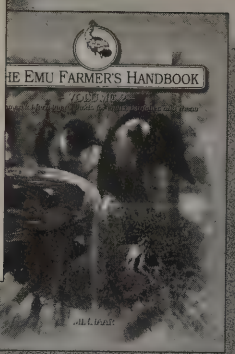
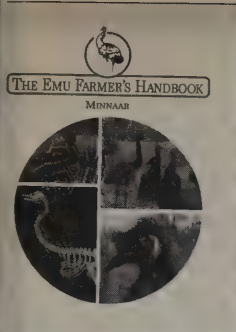
A reconstruction sequence of the head of the Yde girl, discovered in 1897 in a peat bog in the Netherlands, and dating from the first centuries BC/AD. Right: The life-like final wax-

work created from the head reconstruction. Below, left: The head from, which the milled polystyrene skull was reconstructed, as it was found. The sequence

shows the meticulous recreation of the musculature and the facial features, and then the completed clay model from which the waxwork is fashioned.







**The Emu Farmer's Handbook**

Phillip Minnaar and Maria Minnaar. Vol. 1, 1992; 177 pp. \$40 (\$47 postpaid). Vol. 2, 1998; 332 pp. \$48 (\$55 postpaid). Nyoni Publishing, distributed by Ratite Buyers Service, PO Box 310, Margarel, TX 76370, 800/722-9353, 940/563-3221.

The emu—large, flightless birds, cousins to the ostrich, rhea, kiwi, cassowary, and the extinct moa—are said to have roamed

“At the dawn of time in Aboriginal mythology, the world was shrouded in darkness, for this was the time prior to the creation of the sun, and the skies were lighted only by the stars and the moon. Two of earth's primeval creatures—the emu and the brolga—began a nocturnal argument about whose future chicks would be more important. As the argument heated up, the brolga rushed to the emu nest, grabbed the emu egg and tossed it far into the sky. The shell erupted and

Australia for eighty million years. Aboriginals used them for meat, feathers, leather, and an oil for muscle aches, sore joints, inflammation and swelling. Today the emu is farmed in Australia, the United States, and elsewhere as a commercial meat and leather animal. The meat is like beef, yet very low in cholesterol and fat. Emus can be raised organically without antibiotics or growth hormones. They are curious and docile, and enjoy humans.

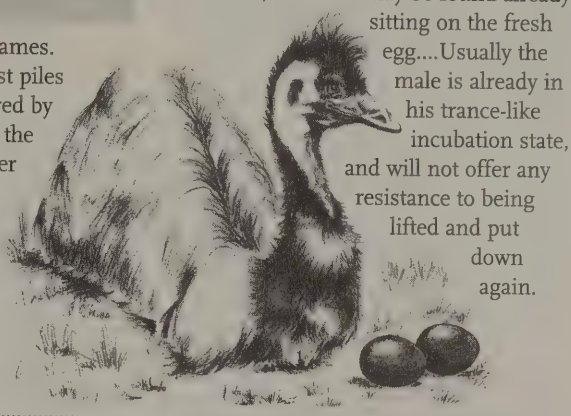
The best books about emu ranching are the two volumes of the **Emu Farmer's Handbook**. Volume 1 covers the basics: emu anatomy, nutrition, breeding, egg and chick care, diseases and injuries. Volume 2 includes updates on health, nutrition, and embryonic development, and addresses farm layout and design, business practices, slaughter, marketing, meat cuts, leather, and emu oil. It expands beyond emus to the other members of the ratite family. —Silke Schneider



Sexing the bird in a standing position.

the yolk burst forth amidst flames. These flames splashed against piles of wood that had been gathered by the Sky People, thus creating the sun. The Sky People still gather and ignite a pile of dry wood upon hearing the morning laughter of the kookaburra.

“Most birds will not object to their eggs being collected, as they generally become very tame and

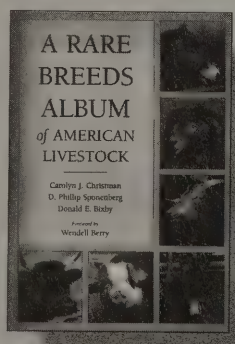


docile during breeding season. In order to cause the least amount of stress, it is a good idea to collect eggs during feeding time...This way the birds will be too busy eating to notice... As the breeding season continues, the male may be found already sitting on the fresh egg.... Usually the male is already in his trance-like incubation state, and will not offer any resistance to being lifted and put down again.

**A Rare Breeds Album of American Livestock**

Carolyn J. Christman, D. Phillip Sporenberg, and Donald E. Bixby, 1997; 118 pp. \$29.95 (\$33.95 postpaid). The American Livestock Breeds Conservancy, PO Box 477, Pittsboro, NC 27312, 919/542-5704, fax 919/545-0022, albc@mindspring.com.

As I am writing this review, I get a call from a colleague at the Memphis Zoo. “We need information about the Caspian horse; any ideas?” I turn to the **Rare Breeds Album of American Livestock** in front of me. In two minutes, I have a chapter about this critically rare horse (about fifty individuals in



the US, 300 globally). I have a contact address, phone number, email.

Seventy breeds of livestock in America are rare. What would happen if these breeds of asses, cattle, goats, horses, pigs, and sheep were to become extinct? Agriculture will have lost the genetic resources necessary to adapt to changes in the environment and human needs. And humans will be deprived of the flash of a Spanish Mustang in the misty morning, the rich palette of colors in a flock of Navajo-Churro sheep, and the gentle lowing of a Cracker cow to her newborn calf.

There is no noise in this book, its information is right to the point. There is nothing like it; I use it all the time. —SS

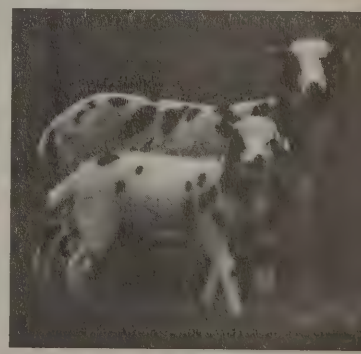
other countries  
Status: Rare  
Sheep with spots have been described in many cultures throughout history, appearing in works of art from the Far

East, Middle East, and Mediterranean regions. Among these accounts is the Biblical story of Jacob, who bred spotted sheep and for whom this breed is named.

Jacobs are small, horned, black and white sheep....The Jacob is a multi-horned or “polycerate” breed. Most animals have two or four horns, though six horns also occur.

Spotted sheep of all shapes and sizes, including spotted Jacob-Dorset and other crosses, have been sold as Jacobs to unsuspecting buyers. Identifying and recording the purebred Jacob population has been a continuing challenge for American breeders.

- Jacob Sheep Breeders Association, 6350 E. County Road 56, Fort Collins, CO 80524-9340, (970) 484-3344.
- Jacob Sheep Conservancy, 1165 E. Lucas Road, Lucas, TX 75002, (972) 727-0900.



Jacob sheep.



## Sleeping Where I Fall

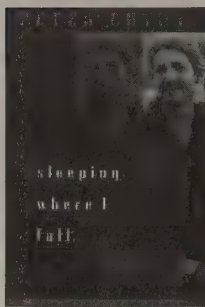
A Chronicle

Peter Coyote. 1998; 367 pp. \$26. Counterpoint.

Peter has recreated a tableau of some of the most Felliniesque characters ever to grace the pages of a nonfiction work. What works here is the utter lack of varnish, for this is neither a defense nor an apologia for the 1960s. It is a description of Peter's odyssey through some of the important players and communities that flared briefly and then burnt out. By pulling back the curtain on the stage, wings, and dressing room of the sixties, with the sex, drugs, and rock-and-roll intact, he reveals a world without a trace of glamour. This is the world that Tom Wolfe and Joan Didion only glimpsed and interviewed, the one George Leonard skirted. Were flowers placed in gun barrels at the Pentagon? For sure. But guns were also placed next to people's temples and fired. It is as if an entire urban village became a nonstop *Commedia Del Arte* for several years, until the sheer intensity destroyed or scattered all but the hardiest. Not until the laughter died off were the bodies counted. This is not the hero's journey. Having read it, no one will pine to have been in his shoes, on his chopper, or in his body. This is the survivor's tale. Peter's opportunism is not hidden. His hustling gift of the gab got him into the worst and "best" of the sixties. He uses the same gift to take the reader back.

—Paul Hawken

“Managing to chew and swallow seven or eight buds [of peyote] apiece was an achievement.... We went outside into a cold, dazzlingly starry night, stunned and shocked by the beauty of the world. We separated, wandering off to follow our own personal predilections. I felt as if I had been transformed into a small wolf and spent the greater part of the night



dog-trotting effortlessly through the Iowa cornfields, following scents and colors, marveling at these newly heightened powers. At one point I stopped to look down and was amazed to see little dog tracks in the furrowed ground where my footprints should have been.

This event haunted me for years, and was too palpable to dismiss as a hallucination. Around the time I left the Mime Troupe in 1977, I met Jim Koller, a fine poet and editor of a respected poetry magazine called *Coyote's Journal*. The logo of the journal was a Coyote footprint, and the first time I saw it I recognized it as the paw print I had seen frozen in the Iowa ground. I realized that the "small wolf" that had come alive inside me was actually

a coyote. Not long afterwards, I met a Paiute-Shoshone shaman named Rolling Thunder with whom I became quite intimate. When I told him the story, he regarded me seriously and asked me what I was going to "do" about it. I had no idea what he meant or expected at the time, but during the turmoil of leaving the troupe and pondering my deepest intentions, I concluded that I had been offered an extraordinary gift and felt compelled to honor it. Without fully understanding why, or what it might mean to me, but needing to mark the occasion somehow, I began using Coyote as a last name. The change in identity itself would come somewhat later.

“The unexpected was commonplace at Mime Troupe performances. When church bells drowned out a performance, the entire cast spontaneously began pantomiming speech, pretending that we were screaming at one another and could not be heard. When a noisy drunk clambered onstage in midperformance one day, I embraced him, in character, as if I had mistaken him for a lover. We twirled around the stage together in an infatuated dance, flirting, while the audience roared its appreciation. On the fourth blissful pass, I "accidentally" danced him off the edge of the stage back onto the grass. Whatever pique might have been generated by his dismissal was mitigated by the applause, and he joined me onstage for a grand bow while the audience cheered the troupe's adaptability and his good sportsmanship.

“The deeper implications of anonymity were lost on Abbie Hoffmann and Jerry Rubin, both of whom came to investigate our activities in late 1966.... While egocentricity may be as authentic as anything else, performing under its influence does not represent a new form of any kind, and we criticized Abbie for confusing the issue.

Abbie was and remained a close friend of mine until his disappearance underground after selling drugs to an undercover narcotics cop, but a friend with whom the Diggers had pronounced disagreements. One morning he woke up Peter Berg by pounding on the door and shouting in his pronounced New England twang, "Petah, Petah, I bet you think I stole everything from ya, doncha?" This was indisputably true. Berg stumbled to the door, regarded the cheerful hairball before him as if he were sucking a lemon, then responded sleepily, "No, Abbie. I feel like I gave a good tool to an idiot." He closed the door, and that was the last time they spoke.



Peter Coyote is a film and television actor (he's the only nice adult male in *E.T.*), former Chair of the California Arts Council, and

an old friend of Whole Earth. *Sleeping Where I Fall* is about his time with the Diggers, the commune formed by members of the

San Francisco Mime Troupe in the Haight-Ashbury in the 1960s.

—PW

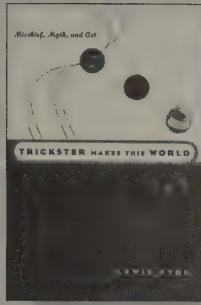
The timeless domain  
in our multiverse of  
hearts, imaginations,  
vividness, and candor.  
Time lived in  
sweet lips,  
empty mind,  
non-ordinary  
goings on.  
Heard in bardic voices,  
dawn songs, festival  
musics, dances & rites.  
Humans at their  
tragi-comic best,  
Their post-Pleistocene  
history of renewals.



## Trickster Makes This World Mischief, Myth, and Art

Lewis Hyde. 1998; 417 pp. \$26.  
Farrar, Straus and Giroux.

In a new book as generous and delightful as his earlier *The Gift: Imagination and the Erotic Life of Property*, Lewis Hyde brings his heartfelt scholarship to the figure known as Coyote, Raven, Krishna, Monkey, Hermes, Loki, or Eshu. He cites the artists Cage, Picasso, Duchamp, and Ginsberg as perpetrators of trickster's shameless ability to turn limitations to his, and, in these cases, our advantage by finding a way to slip

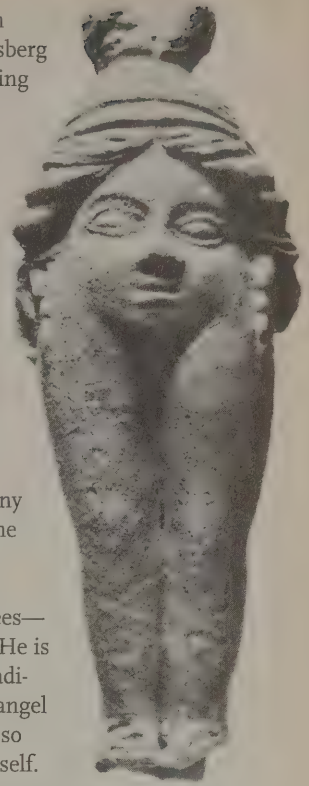


through the porous wall of preconception and widen the field of play. Hyde also explores the life of Frederick Douglass for its black/white, enslaved/ free, illiterate/articulate shape-shifting qualities. Using poetry, myth, dream, humor, history, and fiction, Hyde employs some of the tools of trickster's trade to inform, enchant, and help us make this world. —Suzie Rashkis

forth; the poet himself seems located at the pivot point between “Lord” and “caw.” Each phrase immediately calls up its opposite. If you think everything belongs to the Lord, you are wrong, for the crows own this graveyard; if you think everything belongs to the crows, you are wrong, for the material world hides the spiritual. The dead are with us; the dead are carrion for

the blackest birds. Between such assertions is where we find Ginsberg himself, the ironic prophet, hoping the universe itself will tell its secrets, but turning on them if they congeal into mundane human truths.

“At the end of the woodland dance with the sixteen-thousand milkmaids, Krishna disappears, leaving his lovers bereft, mystified, longing. The thief's last theft is to steal himself away. Now, what sort of revelation is it that follows loss?...The messenger himself left without delivering any message. All he did was break the butter jars, send the flute tones over the garden wall, steal some clothing, uproot a few arjuna trees—he never said what it all meant. He is not the declarative speaker of traditional prophecy, but an erasing angel who cancels what humans have so carefully built, then cancels himself.



## The Spell of the Sensuous Perception and Language in a More-than-Human World

David Abram. 1996; 326 pp. \$14. Pantheon.

The spell is one many naturalists, artists, children, dreamers, outcasts, and mystics have been in the grips of for some time. It's real magic, not trickery. It's a way of seeing that we are of the world, that our languages too, are not so much of us, but of this same world. Our abilities to sense and to communicate are

yet another way Earth expresses itself. It depends on our mutual, participatory perception with each and every other worldly thing. Heady stuff; holy, soul-y stuff too.

But why are the shadows of doubt so prevalent? David Abram argues that perhaps our beloved alphabet could be to blame. The abstraction of direct experience into symbolic representations of human-made sounds enforces the notion, indeed the belief, that the power of language is solely the privilege of humans. An alphabetized civilization—this is where trickery begins and the magic of true experience is scorned. But Abram holds out hope that a new synaesthetic participation with the

world through writing can emerge.

Although there were parts of the *Spell of the Sensuous* when I wished the author had moved more slowly, taken smaller steps to make his points instead of assumptive leaps (and let up a little on the “my time among the shamans” shtick), on the whole, Abram does a marvelous job rolling solid academic scholarship together with poetry and experiential stories. It helps that he is telling me what I want to hear: the lake,, the maple, and the dragonfly speak to me, speak through me; without them I don't have much to say. It's a shame that most skeptics will likely never pick up this book or allow themselves back into the conversation. —ET

“As a Zuñi elder focuses her eyes upon a cactus and hears the cactus begin to speak, so we focus our eyes upon the printed marks and immediately hear voices. We hear spoken words, witness strange scenes or visions, even experience other lives. As nonhuman animals, plants, and even “inanimate” rivers once spoke to our tribal ancestors, so the “inert” letters on the page now speak to us! *This is a form of animism that we take for granted, but it is animism nonetheless—as mysterious as a talking stone.*

“With the phonetic *aleph-beth*...the written character no longer refers us to any sensible phenomenon out in the world, or even to the name of such a phenomenon...but solely to a gesture made by the human mouth...A direct association is established between the pictorial sign and the

*vocal gesture, for the first time completely bypassing the thing pictured.* The evocative phenomena—the entities imaged—are no longer a necessary part of the equation. Human utterances are now elicited, directly, by human-made signs; *the larger, more-than-human life-world is no longer part of the semiotic, no longer a necessary part of the system.*

“Perception...is an attunement or synchronization between my own rhythms and the rhythms of the things themselves, their own tones and textures....In this ceaseless dance between the carnal subject and its world, at one moment the body leads, at another the things. In one luminous passage...Merleau-Ponty writes of perception in terms of an almost magical invocation...  
The sensible thing, commonly consid-

ered by our philosophical tradition to be passive and inert, is consistently described in the active voice: the sensible “beckons to me,” “sets a problem for my body to solve,” “responds” to my summons and “takes possession of my senses,” and even “thinks itself within me.” The sensible world, in other words, is described as active, animate, and, in some curious manner, alive...

Are such animistic turns of phrase to be attributed simply to some sort of poetic license that Merleau-Ponty has introduced into his philosophy?...I think not. Merleau-Ponty writes of the perceived things as entities, of sensible qualities as powers, and of the sensible itself as a field of animate presences, in order to acknowledge and underscore their active, dynamic contribution to perceptual experience.



## KUNDUN

(Director: Martin Scorsese; 137 min.). Spiritual and sumptuous, historical and haunting, this tale of Tibet is my pick for the best 1997 film. It tells the story of the fourteenth Dalai Lama from his discovery in 1937 as a child to his escape to India in 1959. Scorsese has crafted a magnificently stylized docu-drama—from Philip Glass's score, inspired by liturgical Tibetan music, to cinematographer Roger Deakin's gold-toned images. Screenwriter Melissa Matison, who wrote *E.T.*, must be given credit. Once again, through the Dalai Lama's life, she presents a story of faith.

Kundun is also about enhanced perception, beginning with a close-up of the child's eye and ending with the Dalai Lama looking through a telescope at his now-distant native land. Kundun is about enlightenment; light itself is central—both inner and outer. His test is his commitment to non-violence, even as it leads to the death of his loved ones and other Tibetans. After the Chinese invasion of Tibet, he takes to heart Mao's statement: "Socialism and Buddhism can coexist." Mao later "enlightens" him in Peking when he spouts: "Religion is poison." The juxtaposition of a line of dialog with a striking image is, perhaps, the most pointedly political scene about violence and non-violence: as parts of the Dalai Lama's father's

*Kundun.* Martin Scorsese with Tulkus Jamyang Kunga Tenzin, who portrays the Dalai Lama at age five.

M. GREENWAY. ©GREENWAY/FINELINE FEATURES.



corpse are fed to vultures, a voice-over announces that China demands Tibet's submission.

From *The Last Temptation of Christ* to the unbridled violence of *Goodfellas*, Scorsese has magnificently evolved his senses of loyalty, faith, betrayal, and violence, now to encompass the latest incarnation of Buddha!

## PASSION IN THE DESERT

(Director: Lavinia Currier, 93 min.). The summer 1998 release of Lavinia Currier's cinematic adaptation of Balzac's short story is set in the Egyptian desert in 1798 (filmed in Morocco). *Passion* centers on Augustin (Ben Daniels), a French officer from Napoleon's army temporarily lost in the desert with a painter after a sandstorm. He is protecting the painter (Michel Piccoli) who, in this parched landscape, drinks his paints to combat thirst. Augustin learns how to survive from a leopard. The leopard changes from enemy to ally to playful companion. Augustin becomes more like a desert animal himself. His army unit returns. The question beautifully posed by the film is: can this officer go back to civilization? At what price?

Currier's first feature is a tour de force: she treats the leopard with awe, elements (such as heat and sand) with painterly richness, and humanity with intelligent skepticism.

## SMOKE SIGNALS

(Director: Chris Eyre; Screenwriter: Sherman Alexie; 89 min.). A first film script by Sherman Alexie (author of *The Lone Ranger and Tonto Fistfight in Heaven* and *The Fancy Dancer*) and the first feature by Chris Eyre—both Native

American artists. This road movie (a bus trip), blending comic incident with dramatic story, travels into the past of two young Native American men who must learn to forgive their fathers and themselves.

Ben Daniels, in *Passion in the Desert*.

## MARIUS ET JEANNETTE

(Writer/director: Robert Guédiguian; 102 min.) offers not only an unusual love story of a working-class couple in their forties but, by embracing their neighbors, a generous and affectionate exploration of community. Set in sun-drenched Marseilles, this dramatic comedy leaves you with the gift of thoughts to chew on: what might life be? ⊕

Annette Insdorf, Director of Undergraduate Film Studies at Columbia University, is the author of *Francois Truffaut and Indelible Shadows: Film and the Holocaust*. She has been Truffaut's translator and panel organizer at Telluride (where she also translates). The French Ministry of Culture named her *Chevalier dans l'ordre des arts et des lettres* and later knighted her with *palmes academiques*. With Roger Ebert, Dr. Insdorf co-hosts the Cannes Film Festival coverage for BRAVO/IFC.

## Home Film Festival

800/258-3456.

Although such visually powerful films should be seen on the big screen, the next best thing is videocassettes. My pick of videos is *Home Film Festival*, a mail order service for both rental and purchase. —AI

## HOME FILM FESTIVAL



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## Plants of Love

### The History of Aphrodisiacs and A Guide to Their Identification and Use

Christian Ratsch. 1997; 205 pp. \$19.95. Ten Speed Press.

Books on aphrodisiacs are, in general, plagued by three recurring problems: a lack of science, uninspired scholarship, and, oddly, dullness. As scientific knowledge of the subject is in its infancy, even the most technically oriented books do little to mitigate the first problem. Ratsch's *Plants of Love*, refreshingly, does a great deal to alleviate the latter two complaints.



For one, this is a coffee-table book, patterned after Shultes's and Hofmann's beautiful *Plants of the Gods*, and is filled with pictures. The botanical lore is up-to-date, comprehensive, and often enough dangerous. Ratsch inclines to the "get-close-to-your-subject" school of ethnobotany, and his enthusiasm is often evident. In addition to the history, mythology, and chemistry of over one hundred plants, the good professor has included several dozen recipes for teas, tinctures, baths, ointments, pills, incenses, snuffs, and enemas. That many of the ingredients are illegal in the United States is certainly an annoyance, but in no way detracts from the value or usefulness of the book. —Dale Pendell

“ In addition to...secret rituals, the iboga root is also used as an aphrodisiac or love drink, often in conjunction with yohimbé bark. Here, the root and bark pieces are boiled together and the resulting liquid drunk. The effects appear to be even stronger than with a preparation of pure yohimbine. The iboga root is also said to be a good aphrodisiac and agent for increasing potency when used alone in low dosages. The main ingredient of

iboga, the indole alkaloid ibogaine, is said to produce continuous erections for up to six hours. The pleasures that can be experienced with a partner during this time are said to be indescribable. Although ibogaine has gained recognition in recent years as a psychotherapeutic agent and a remedy for heroin addicts, reports on its aphrodisiac qualities are quite sparse. To date, no scientific tests have yet been carried out.



Left: *Tabernaemontana iboga*, Geographical distribution: West Africa.

Below: In China, opium was smoked in preparation for erotic adventures and even while the "stem of jade" and the "lotus flower" were joined.



## Hemp for Health

### The Medicinal and Nutritional Uses of Cannabis Sativa

Chris Conrad. 1997; 280 pp. \$14.95. Healing Arts Press, One Park Street, Rochester, VT 05767, www.gotoit.com.

One might think that issues around

the medical uses of the hemp plant, *Cannabis sativa*, would be worked out by doctors and other medical researchers. That such medical decisions are being made by law enforcement officials shows

that the War on Drugs is a culture war rather than about protecting public health interests. Even the voting voice of the people in a state like California, where the Medical Marijuana Initiative passed overwhelmingly, has little-deterred the zeal of certain entrenched bureaucracies, such as the Drug Enforcement Agency.

If you are unfamiliar with the issues involved, and with the ever-expanding medical possibilities of this ancient crop, Chris Conrad's *Hemp for Health* provides an up-to-date and reliable overview of the subject.

The other occupant of the medical marijuana shelf is *Marijuana: The Forbidden Medicine*, by Lester Grinspoon and James Bakalar, who have been tireless researchers

in the drug field for many years now. But Conrad's book, besides being newer, has an immediacy that is lacking in the mostly anecdotal Grinspoon-Bakalar work. Conrad's book is oriented toward patient activism, presenting what marijuana can do for you right now, and outlining what you can do to use it.

Chapter topics in *Hemp for Health* include history, health-care systems, chemistry, taxonomy, neuropharmacology, and legal issues, as well as specific medical applications. Useful appendices at the back of the book deal with the nuts and bolts of getting started with cannabis therapy, well-tested recipes, and a tabular compendium of the medical indications for cannabis. —DP



Roman drawing of cannabis from Constantinopolitanus (A.D. 500).

## “ Cannabis Therapy Reference Table

Condition: Method of Application: Therapeutic effect

Anorexia: Resinous herb smoked or eaten: Stimulates appetite, increases enjoyment of food, increases intake of liquids (due to dry mouth)

Arthritis: Resinous herb smoked or applied topically: Pain relief, anti-inflammatory

Burns: Topically applied decoction of root: Soothes pain, speeds healing

Chronic fatigue syndrome (CFS): Resinous herb smoked in large doses along with exercise and posture control: Energizes, motivates individual, allows introspection

Depression: Resinous herb smoked or eaten: Raises spirits and stabilizes mood, helps motivate the patient to act

Dystonia: CBD extract: Relaxes muscles, eases spasms

Migraine: Resinous herb smoked or eaten, tinctures: Eases pain, acts as prophylactic to prevent migraine attacks

Nursing mothers: Hempseed eaten or taken boiled in water or milk: Stimulates lactation, increases available GLA in mother's milk

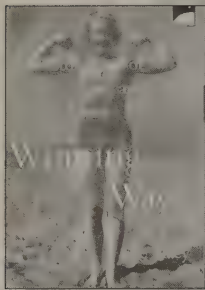
Psoriasis: Hempseed oil, EFA, lotion: Moisturizes skin, soothes itching

Tourette's syndrome: CBD extract: Helps control physical twitches and verbal outbursts



## Winning Ways A Photohistory of American Women in Sports

Sue Macy. 1996; 217 pp. \$5.99. Scholastic.



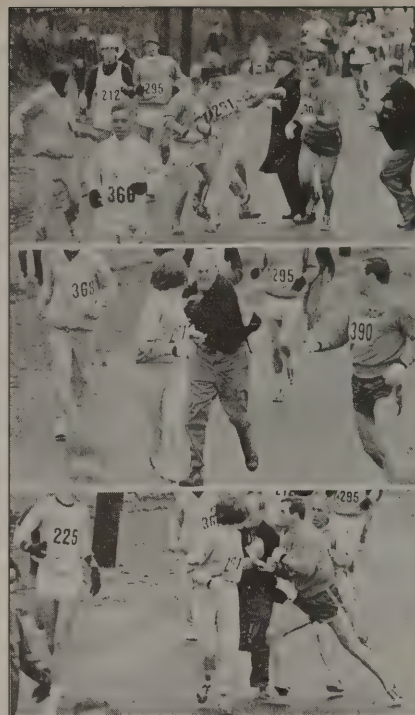
Babe Didrickson set Olympic and world records in javelin, hurdles, and high jump, before becoming a champion golfer. "After hearing that Babe played basketball, football, baseball, and many other sports besides running track, a reporter asked her, 'Is there anything at all you don't play?' 'Yeah,' said Babe without missing a beat, 'dolls.'"

Sue Macy uncovers historical gems— anecdotes, photographs, illustrations, news clips, and commentaries—that show the rise of women's sports in America since the 19th century. What's most fun about **Winning Ways** is how Macy weaves in the social context— clothing styles, the medical "wisdom" of keeping women out of sports, the fears that female athletes would become "mannish"— into the

colorful tales of daredevil pilots, world champion runners, and baseball players.

Although corporate America and television have just discovered women's sports, there is a long history of dynamic female athletes who, by their very existence, pushed the limits of social norms, defied the rules, and eventually freed us from them. Macy shows today's female athlete where she came from. In a society where people tend to focus on individual achievement and forget the pioneers who paved the way, **Winning Ways** helps the post-Title IX generation connect with the gutsy women from our past. — Nancy Levin

"Annie Edson Taylor was the first person, man or woman, to go over Niagara Falls in a barrel and live to tell about it. What possessed her to risk life and limb to "shoot the Falls"? Before the plunge, Taylor said she was giving it a try simply because "Nobody has ever done that," but



Two miles after the start of the 1967 Boston Marathon, race director Will Cloney (in dark coat and hat) tried to snatch the number from Katherine Switzer's (#261) chest. Then Boston Athletic Association trainer

Jock Stemple (in dark jacket) also ran after her. She broke away with the help of her running partner, Tom Miller (#390) and went on to be one of nine women who finished the race. Women were finally invited to enter in 1972.

afterward she confided that she also had another motive. Taylor owed a lot of money on a cattle ranch that she had bought in Texas, and she hoped to earn enough from her newfound fame to get out of debt. Following her historic moment, though, Taylor declared that she wouldn't do it again, even for a million dollars. "If it was with my dying breath I would caution anyone against attempting the feat," she said. "I would sooner walk up to the mouth of a cannon, knowing it was going to blow me to pieces, than to make another trip over the Falls."

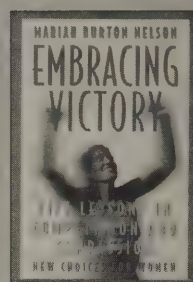
Right: The Women's International Bowling Congress held its first tournament in 1917. By 1923, Minnie Beringer was one of the nation's top bowlers. She regularly scored higher than 200.



## Embracing Victory Life Lessons in Competition and Compassion

Mariah Burton Nelson. 1998; 288 pp. \$23. William Morrow.

With her 1994 bombshell, *The Stronger Women Get, the More Men Love Football*, Mariah Burton Nelson became a target of angry football fans who felt threatened by her treatment of the sport. Nelson took notes as they railed and bombarded her with criticism, saying almost anything to "win" the argument against her. In those notes were the seeds of **Embracing Victory**, a book that promotes a positive model of competition for women.



A Stanford alumna and former professional basketball player, Nelson has built a successful career out of being a voice on the cutting edge of women's sports. In **Embracing Victory** she presents a framework for understanding all competition, athletic or otherwise. She turns the military model of competition on its head. The competitor is not the enemy to be defeated but more like a valued friend, because she or he pushes you to be the best you can be—which begs the question: can there be a friendly game of pro football? —NL

"Competition is a feminist issue. Because of sexism, women know what it's like to be subordinate, to be defeated, to be losers. We have been denied opportunities to compete with men on an equal basis. We've seen men react to female victory as if it signified male defeat. All this cultural conditioning affects how we compete, and with whom. But everything changes as we begin to define competition for ourselves.

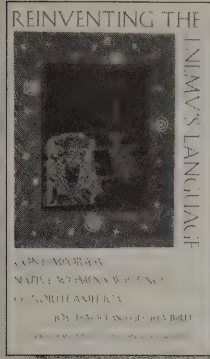


## Reinventing the Enemy's Language

Contemporary Native Women's Writings of North America

Joy Harjo and Gloria Bird, editors.  
1997; 576 pp. \$27.50. W.W. Norton.

Live love lose. Survive survive survive. In the face of a world that has for so long wished them gone, the warrior women collected in this volume teach us new and ancient ways to exist. Their words of sublime perception and deeds of victorious resistance make vivid the meaning and value of cultural reclamation. —ET



“ In 1973, inside Wounded Knee, during the siege, volunteers set up a clinic. Mostly this was the work of our women. There were frequent firefights and as a result we had a number of people with gunshot wounds. I remember a sign tacked to the wall of our homemade “hospital”: *Bleeding Always Stops if You Press Down*. This was meant literally, but for me it was

symbolic—in my mind Indian women are always pressing down hard to stop the bleeding of their hearts. It is not easy to be a native woman. I am proud of Indian women, proud of their courage in adversity, for holding their tribes together. After five hundred years of being held in subjection, we are finally standing up on our hind legs. Together with my sisters from many tribes, I am a birth-giver, a rebirth-giver, fighting to ensure a life for unborn generations. I am a Sioux woman!  
—MARY BRAVE BIRD (LAKOTA)

## Women's Sports Connection

Nancy Levin, publisher and editor. PO Box 31580, San Francisco, CA 94131-0580, 415/241-8879, fax 415/586-3214, Wmnsports@aol.com, www.women-sports.com.

This popular regional publication of women's and girls' sports nobly and capably attempts to make up for the sore lack of coverage in most newspapers' sports sections. Lucky for us, **Women's Sports Connection** will soon be going national, and you'll be able to keep up on your favorite athletes and teams, from local amateur leagues and clubs to the pros, without having to wade through pages of diet and makeup tips. For a sample copy, drop them a line with your name, postal address, phone, and email.  
—Lightning Liz Thompson



“ Dorothy [Delasin] has big-time potential as a golfer, but not the big-time attitude. “She’s so diligent at practice. So focused. She uses every club in the bag when she comes here.”...

Still a regular on her high school team, she won the same tournament (U.S. amateur) as Tiger Woods, but is not jealous of his stardom because “he earned it.” Dorothy recognizes that “he has reached his goal already, and I’m going on my first step.”...

“My steps are the tournaments. I have to improve my long irons. I’m OK in the rest,” said Dorothy. “I definitely have to work on my mental game. I have a sports psychologist [who]

helps me relax through tournaments.”

Playing her first LPGA event, the Longs Drugs Twelve Bridges tournament, will be another notch on her belt.

“ Above the city, the constellation of angels glows. In the tidal waters, mud-red fish race against the infiltration of air. In the tribal dreams thick with broad leaves and clans of red fish and moons, the perceptive ones sigh. Those who have lost their tribes, their dreams, world over, feel their eyes sealed with concrete and wake aching to see the world.

Wake aching like an orchid burned black from the cold, its Kirlian aura unfurling vermillion into the teething shadows. If an orchid ached, what of the human soul?

From the temple of the dream-walkers, I emerge, standing with one cloudy hand on the dark red maples, breathing the lunar downpour of air.

It is the temple of reedy rivers, its door made of shifting sand and yellow canaries. There are many doors; I am one of them. My eyes can be as glittery as dragonfly wings. I emerge and see the young woman who lives in the dark cracks of the city.

—ANITA ENDREZZE (YAQUI)

“ My daughter’s induced labor was unnatural and difficult, monitored by machines, not by touch. I was shocked. I felt as if I’d come full circle, as if I were watching my mother’s labor and the struggle of my own birth. But I was there in the hospital room with her, as neither my mother had been for me nor her mother for her. My daughter and I went through the labor and birth together.

And when Krista Rae was born she was born to her family. Her father was there for her, as were both her grandmothers and my friend who had flown in to be with us. Her paternal great-grandparents and aunts and uncles had also arrived from the Navajo Reservation to honor her. Something had changed.

Four days later, I took my granddaughter to the saguaro forest before dawn and gave her the name I had dreamed for her just before her birth. Her name looks like clouds of mist settling around a sacred mountain as it begins to speak. A female ancestor approaches on a horse. We are all together. —JOY HARJO (MUSCOGEE)

## What is Title IX?

NANCY LEVIN

Title IX is the portion of the Education Amendments of 1972 that prohibits sex discrimination in educational institutions that receive any federal funds. In brief, Title IX states: “No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving Federal financial assistance.”

Over twenty-five years after the passage of Title IX there is good news and not-so-good news.

The good news:

✱ In 1971, 1 in 27 girls participated in high school sports. In 1997, that figure was 1 in 3. For boys, the figure has

remained constant at 1 in 2.

Did you know?

✱ In the past five years, corporate sponsorship of women’s sports has more than doubled: compare \$600 million in 1997 to \$285 million in 1992.

✱ In the 1990s the number of women playing hockey in the United States has jumped from 5,533 to 20,555.

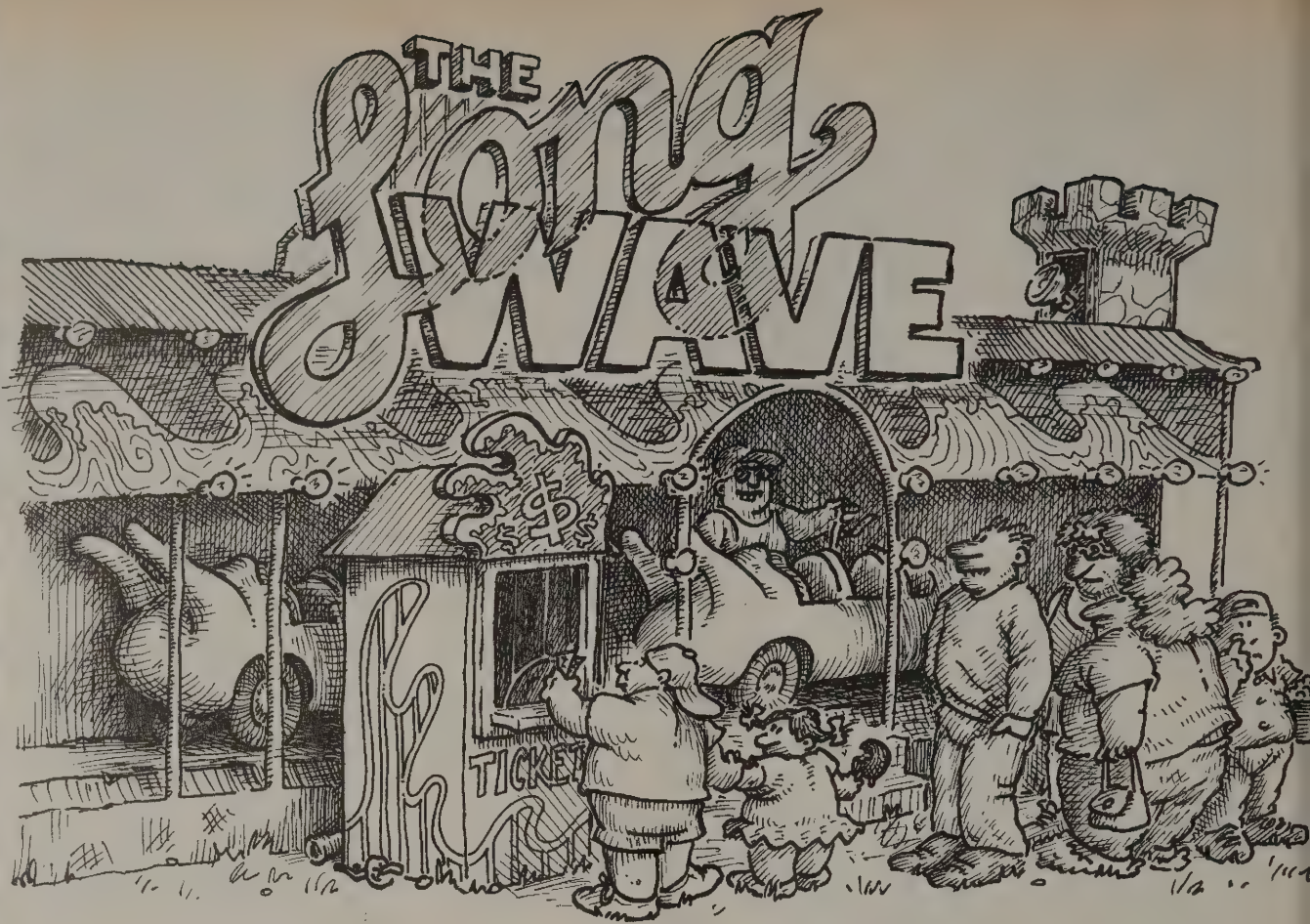
Still a ways to go:

✱ 21% of college sport operating budgets and 25% of the athletics recruiting dollars are allocated to women’s sports.

✱ 94% of Los Angeles television news sports coverage goes to men’s sports. Women’s sports get 5% and gender neutral topics 1%.

✱ In 1971, over 90% of women’s college teams were coached by women. In 1998, less than 50% of women’s college teams are coached by women.





## or Why Asian Economies are Collapsing and the Democrats are Cutting Welfare

◆ Donella H. Meadows ◆ Illustrations by James Donnelly

**D**OZENS OF PEOPLE are eager to explain the collapse of the Asian Tiger economies. Few of them predicted it. Other economic implorations, from the 1995 failure of Britain's venerable Barings Bank to the 1987 dive in the US stock market, have been explained primarily after the fact.

Similarly, the 1994 rise to Congressional power of the US right was not predicted, nor convincingly accounted for afterward as a rebellion of white male voters. The conservative shift is not a male, American, or sudden phenomenon. For almost two decades there has been an unrelenting worldwide pressure pushing right.

Unpredicted. Poorly explained even afterward. In the 1980s in addition to Ronald Reagan and Margaret Thatcher there were conservative swings throughout Europe. Even Canada, the Netherlands, and Denmark questioned their long-entrenched welfare states. At the fascist edge arose anti-government militias in the United States, neo-Nazis in Germany, and anti-Semitic Jean Marie Le Pen in France. Vladimir Zhirinovskiy preached genocide in

Russia. Serbian soldiers practiced it in Bosnia. Why? Why now?

"Unpredicted and poorly explained" holds for financial volatility too, which also is not a recent matter and not confined to one part of the world. Barings Bank was one of many casualties of the razor-edge sensitivity of the global capital market. Other examples were the demise of US savings and loan banks in the 1980s, the collapse of the junk bond empire, the burst of real estate bubbles in Japan, the bankruptcy of Orange County, California from overzealous investment in derivatives, and the New Era Fund Ponzi scheme that took in some of the most level-headed portfolio managers in the nonprofit world.

The political economy seems to have wandered into strange territory. All the business indicators were up on the day when the Dow crashed 508 points. The US GNP is rising, but not the income of the average worker. Companies make record profits by firing people. Tax breaks for the rich produce not investment in productive capacity, but speculation in financial instruments untied to real assets. And policies that were considered mainstream twenty-

The domain of community webcraft  
 Getting it right  
 A little, India's net  
 To follow's broad  
 Wide web, the world  
 kin & friends  
 The domain of moving  
 Thestris, faces  
 from strands of time  
 G. H. A. pattern we  
 how the emerg' of  
 is it being?  
 How do we reinvent?  
 What should we do?



five years ago (invest in roads and schools and research, shore up the poor, be generous with foreign aid, preserve endangered species, strengthen environmental regulations, forbid racial discrimination, tax the rich more heavily than anyone else) are now under attack or simply undiscussable. Why? Why now?

Few if any explanations for these phenomena postulate any connection between the rightward political slide and the edgy financial markets. I know of only one group that has not only connected them and explained them, but predicted them.

### Kondratieff, Schumpeter, and Speeches from the Throne

Twenty years ago, a scattered, committed, largely ridiculed group of "long wave" scholars told us to start watching for:

- Stagnation in the real economy and volatility in the money economy
- Social distrust, selfishness, isolationism, scapegoating
- Deflation of real asset values
- Retreat to "basic values" and yearning for the strict imposition of law and order
- Cutthroat economic competition globally, erosion of social compassion locally.

This social and economic pattern has occurred before, they said. It happens every fifty to sixty years. The last time was in the 1920s and 1930s, before that in the 1880s and 1890s, before that in the 1830s. Financial crashes and political conservatism are characteristic of the long wave downturn.

The long wave is also called the Kondratieff wave, after Nicolai Kondratieff, a Russian economist who spent the 1920s studying long-term patterns of industrial output in the United States, France, Germany, and England. What he saw at first glance was the century-and-a-half-long expansion of the industrial revolution. Then he removed the underlying growth trend from the data and discovered—cycling above and below the central upward tendency—a wobbly cycle, decades long, especially in the production of basic industrial commodities such as iron and coal.

The cycle Kondratieff saw (Fig. 1) was not absolutely regular, like the swinging of a pendulum, but its peaks and troughs repeated roughly every fifty to sixty years. When he wrote, the last

trough had been in the 1880s and 1890s. It was accompanied by financial panics and failed banks, including Baring Brothers, which expired in 1890 and was reconstituted by the British government. The next downturn was due in the 1930s, he said. He said that in 1926.

No one took him seriously. Most Western economists still don't take him seriously.

Kondratieff lived through only part of the depression he had foreseen. In 1930, he was jailed by Stalin for protesting the collectivization of Soviet agriculture. He died in prison in 1938. It took the advent of glasnost in the 1980s for the Soviet Supreme Court, at the request of Kondratieff's descendants, to declare that he had been not a criminal against the Soviet state, but a notable and prescient economist.

Kondratieff was not the only person of his era who saw cycles. In 1939, the great economist Joseph Schumpeter hypothesized that technology runs in fifty-year waves. Not waves of invention—human creativity seems to perk along at a fairly constant pace—but waves of adoption, building innovation into the operating hardware of an economy. There seem to be distinct periods when industrial transformations completely change economic production—mechanized textile-making in the 1780s, railroads and steel in the 1840s, electricity in the 1890s, electronics and computers in the 1950s. Between these periods, technologies in practice are elaborated and perfected, but not displaced.

Schumpeter noticed that bursts of technical transformation coincide with upturns in economic activity. He assumed that they were the cause of that activity—that new technology spurred economic growth. Present-day long-wave theory sees the connection as two-way. Innovation causes growth, but growth opens the opportunity for innovation to penetrate the economy.

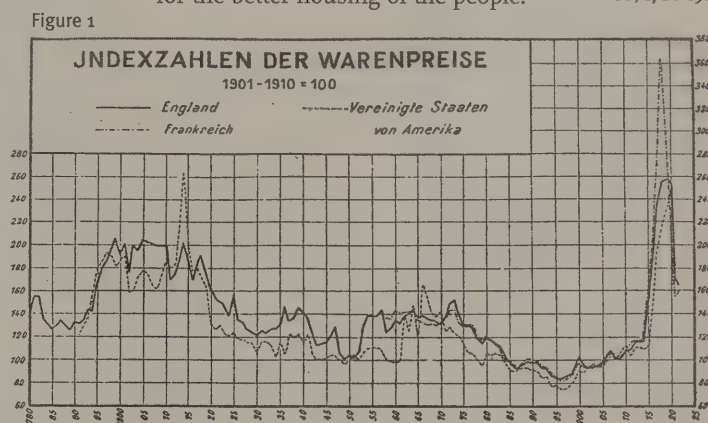
Kondratieff found cycles in industrial production, Schumpeter found them in technical application, and, quite independently, social scientists discovered them in politics. Over the past half-century political scientists have developed "content analysis," a method of classifying

political tracts according to the key words they embody. Applying content analysis to documents such as Republican and Democratic party platforms, or the British monarch's annual "Speech from the Throne" (much like the US president's State of the Union address), several studies in the 1970s and 80s revealed fifty-year political cycles.

Periods of retrenchment, militarism, obsession with the accumulation of wealth, the enforcement of order, and the undoing of social reforms occurred in the 1920s, 1880s, 1830s, 1790s. For example, a Speech from the Throne in 1830 sounds strangely familiar today: "It will be satisfactory to you to learn that His Majesty will be enabled to propose a considerable reduction in the amount of the public expenditure, without impairing the efficiency of our naval or military establishments."

Liberal swings are obvious around 1800, 1850, 1900, 1960. Here is part of a Speech from the Throne in 1907, busy with do-good ideas: "You will also be invited to consider proposals for the establishment of a Court of Criminal Appeal, for regulating the hours of labour in mines, for the amendment to the patent laws, for improving the law related to the valuation of property in England and Wales, for enabling women to serve on local bodies, and for the better housing of the people."

Figure 1  
Kondratieff's graph of index of commodity prices in England, France, and US, 1780-1925.



### Modeling the Economy

So economic upswings, political liberalism, and technical change tend to occur together. Economic downswings correlate with political conservatism and technical burrowing-in. For decades, those observations were just statistical curiosities, with no theory behind them. Why cycles? Why should politics, technology, and the economy oscillate together? Without a theory,



long-wave believers could be dismissed as a bunch of sun spot watchers.

Then in the 1970s Jay Forrester and his team of computer modelers at the Sloan School of Management at MIT came up with a persuasive long wave theory—all the more persuasive because they weren't looking for one.

Forrester was trying to understand how the economy works. He was especially interested in the short-term (four-to-seven-year) business cycle, the most obvious dynamic characteristic of mar-

shoes, cars, health insurance. The second makes *Capital Goods*—the metals, machines, chemicals, concrete, motors, computers, buildings that industry needs in order to turn out refrigerators, shoes, cars, and insurance (Fig. 2).

To a dynamic modeler, the distinction between consumer and capital sectors is necessary not only because of their supply hierarchy, but also because of the different time scales on which they operate. The output of the consumer goods sector lasts from days or

So that's how the MIT team modeled them.

When they did, a short-term business cycle appeared. That cycle came out of the model; it wasn't put in. In Forrester's type of modeling, one doesn't throw in a driving cyclic function to make a cycle come out. Rather, one keeps track of the stocks and flows of the system (factories, inventories, cash flow, orders, sales, etc.), puts in their multiple interactions, and sets them loose to behave in the computer the way they behave in the world—or so the modeler hopes.

Ask a system dynamics modeler why the Forrester model produces a business cycle, and the shortest answer you are likely to get is: delays in the consumer goods sector. Press for a longer answer and you will be told: 1) the consumer goods sector is sufficient in itself to generate the cycle, without help from the capital sector, 2) the four-to-seven-year cycle is an intrinsic harmonic of that sector—like a spring, if you nudge it with almost any input, it responds with its own built-in oscillation—and 3) the reason the oscillation is four to seven years is because of the length of response delays in that sector, especially in building up and selling off inventories of consumer goods.

Hang a Slinky—one of those long plastic springs kids play with—uncoiled from your hand, move your hand up and down, and the Slinky will bounce up and down. No surprise: you're driving its cycle with your hand. Let the Slinky come to a stop and give your hand just one jerk. The Slinky will bounce with its own frequency, in a damped oscillation that eventually stops. Give the Slinky occasional random jerks and it will bounce in messy, imperfect cycles, always tending toward its own periodicity.

According to Forrester, random jerks come constantly from the events of the world—storms, strikes, elections, holidays, accidents, rumors—and the economy responds like a Slinky. It does so because it can't respond instantly. In the real economy of physical stuff, things take time. If you've overproduced you can't sell your stacked-up inventory overnight. If you're underproducing, you can't hire workers, order materials, and gear up a factory overnight. These delays compound one another in causal circles called feedback loops. As business tries to adapt to changing sales, it hires or unhires peo-

Figure 2

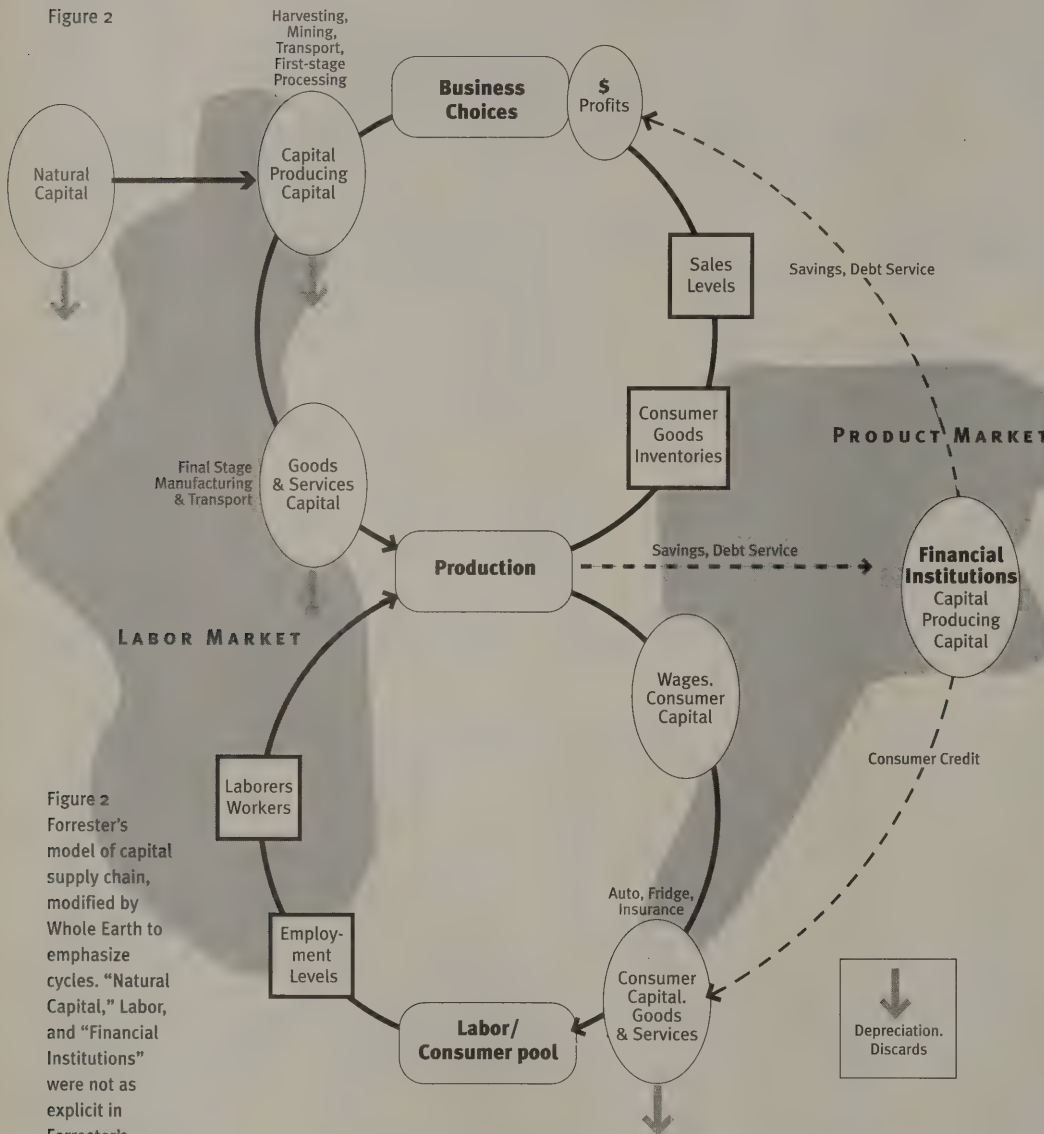


Figure 2 Forrester's model of capital supply chain, modified by Whole Earth to emphasize cycles. "Natural Capital," Labor, and "Financial Institutions" were not as explicit in Forrester's model. Added to emphasize the growing importance of interest rates related to credit. Ovals are forms of capital. Gray areas are complex markets with psychological feedback.

ket economies. Forrester is an engineer, not an economist or historian. At the time he began his economic modeling, he had never heard of Kondratieff or Schumpeter's technical waves or Speeches from the Throne.

He and his team put together a model that was divided into two sectors. The first sector makes *Consumer Goods and Services*, such as refrigerators,

weeks (food, paper, haircuts) to years or decades (clothing, refrigerators, cars). The output of the capital goods sector lasts from decades (machines, boilers, trucks, power plants) to centuries (buildings, roads, ports). The two sectors face different inventory costs, market fluctuations, technical change rates, decision rules, and response times. They have to be modeled separately.





for evidence of a long cycle. They came up with Kondratieff and Schumpeter and, in 1981, Robert Philip Weber's newly published content analysis of *Speeches from the Throne*.

### Why There is a Long Wave

To explain how the long wave works, let's start at the bottom, in the mid-1940s, for instance. Because of the depression and the war, consumers' stocks of refrigerators, houses, cars, and just about everything else are low and old. Families have deferred purchases, nursed along old clunkers, gone without. Finally, the time of troubles is over. Jobs, cash, credit, and confidence are coming back. People flock to showrooms, place orders, deplete inventories. Makers of consumer goods gear up, hire workers, and those additional jobs create even more demand. Car makers and house builders order tools, trucks, lumber, concrete, steel, oil, electricity.

So far, that's just a set-up for a normal business cycle upturn. But this is a long-depressed economy, which has shut down or written off much of its productive capacity. It doesn't take long for the makers of refrigerators and shoes and cars to start running their factories full out. What they need is more factories. That creates a flurry of orders to the capital sector.

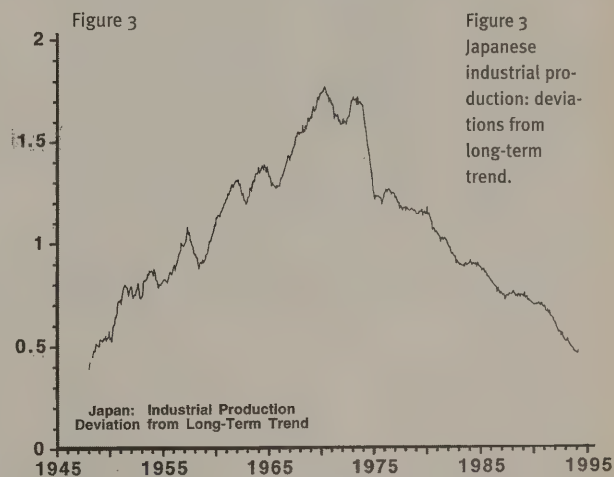
Before long the capital sector is also running at full capacity. Steel mills and machine tool shops are working overtime, but unfilled orders from the consumer goods makers are still piling up. *Before it can fill them, the capital sector has to make steel and machines and tools to expand itself.* That necessity is the central cause of the long wave. Forrester calls it *Capital Self-Ordering*. While the capital sector is rebuilding itself, unfilled orders from consumer goods makers pile up still further. There seems to be no end to the economy's need for productive capacity. The capital sector raises its expansion plans even higher. The result is a long, long boom, the most recent of which took place in the 1950s and 1960s.

The problem for the capital sector, and to a lesser extent for the consumer goods sector, is that it can't distinguish between orders that signify a perma-

nent rise in the scale of the economy and orders that come from a temporary need to fill deficiencies in inventory or infrastructure. Most business planners, faced with month after month of inability to meet rising orders, will expand with increasing urgency. Furthermore, each firm hopes to increase its market share, so it expands a bit beyond what it actually expects to need.

Unemployment is falling and wages are rising, so labor is being replaced by capital, which further increases capital-sector orders. Because orders for goods are straining the capacity to make them, prices rise. The resulting inflation makes real interest rates low or even negative—so it's easy to borrow for expansion. There is a general mood of optimism. Risk is minimal, success is occurring all around, everyone scrambles for a piece of the action.

The result, inevitably, is overbuilding. The inevitability is important to



understand. If you're trying to fill a half-empty bathtub with an open drain (an economy with its consumer goods stock regularly wearing out), you have to turn the input faucet *higher* than the rate of outflow until the tub is filled. Then, to keep it just full, you have to turn the inflow *back down* to equal the long-term outflow. When an economy is making up a capital shortage, it must place orders for steel and machine-tools at a higher rate than it will need in the long term. Then, when it catches up, its orders must decrease. There's no way around that, and it's just about impossible for investors to take it into account. They see the orders and sales in their particular businesses. They sense the prevailing mood and make the best decisions they can. Toward the end of the rising phase of the long wave, those

ple, and that, after a while, affects consumer income, and that, after some more time, affects the very sales to which business is trying to adapt. Trying to catch up, always having to make decisions that can't come to fruition for months or maybe years, managers overshoot and undershoot and overshoot and undershoot.

Much as we like to blame economic downs and ups on presidents or heads of the Federal Reserve System, normal recessions and recoveries are created by business chasing its own tail. The tail is never caught, the market never equilibrates, because in the physical world (as opposed to the world of economic theory) materials, products, people, prices, credit, perceptions, and policies can't change quickly. The four-to-seven-year periodicity of the business cycle comes from the consumer goods sector's one-to-three-year delays in perceiving and believing economic news, in gearing up or down, in dispersing or rebuilding inventories, and in consequent changes in employment and consumer disposable income.

That's why Forrester's model produced business cycles. To his surprise, however, when he ran his simulation out over decades, a longer cycle also appeared; a fifty-sixty-year fluctuation.

He thought it was a mistake. He tried to make the long cycle go away. It wouldn't.

So he looked more closely to figure out why the model was doing that long oscillation. He discovered that it came from a complex of interconnected feed-backs, the most important of which ran between the consumer goods sector and the capital sector. Meanwhile, his students were searching in the literature



decisions are systematically too optimistic.

As the wave approaches its crest, unemployment is as low as it can get, incomes are high, consumers have finally acquired most of the refrigerators and cars they want. Inventories begin piling up. Factories under construction keep coming into production, though now they are no longer needed. (In 1993, as six General Motors plants and two Volvo plants closed and more shutdowns were being planned, enough new plants were still coming on line to build 1.7 million more cars per year. Said the president of Volvo, "The significant overcapacity in the industry in the United States, Europe, and Japan will continue for a very long time.")

At this point competition gets fierce. Cost-cutting becomes mandatory. Manufacturers "downsize" their labor force and pay less to the workers they keep, thereby decreasing consumer demand and making the problem worse. With way more capacity than they need to supply domestic markets, firms cast desperate eyes on foreign markets. Governments, sensing the economic stress, kick in with tax cuts, lower interest rates, deregulation, more social or defense spending, export subsidies, anything that might encourage investment and economic growth. But investment is precisely what is not

needed. Capacity is already too high. Government incentives just permit the overbuilding to get worse.

Finally the weakest competitors falter and with them their employees, suppliers, and lenders. The capital sector gets hit first and hardest. Steel mills and machine shops shut down, people lose their jobs. They stop buying cars, houses, and refrigerators. Those inventories pile up, more factories shut down, more unemployed folks reduce their spending. The virtuous cycles that sustained the boom become vicious cycles feeding the downward slide. *The slide will go on until enough capital plant is abandoned to bring productive capacity in balance with demand.* Then it will go on still longer (Fig. 3, previous page).

Just as the economy inevitably overshoots in the upturn, it undershoots in the downturn, for the same reasons. Managers still don't know where equilibrium demand will be, and this time they guess too low. Confidence is shaken. The mood turns sour. Both lenders and borrowers get conservative, credit dries up, "downsizing" makes even those who are still employed nervous about big purchases. Times get hard and can stay that way for years, until it finally becomes clear that there are too few operating plants to satisfy even the remaining minimal demand. That shortage sets up the conditions for the next upturn.

How can investors so badly over- and then under-estimate the needs of the economy? Conventional economics, which has a religious belief in the acumen of investors, says they can't. That's one reason why few conventional economists believe in the long wave. (There's a joke in which economists explain why there are cycles, if the economy is supposed to be always in equilibrium. "Workers have cyclical preferences for leisure.") But real players in the market have no way of measuring equilibrium demand, knowing what other investors are doing, guessing correctly their own future market share, or, as a system dynamicist would put it, managing a complex system with non-linear feedback loops and tricky delays. They are very attentive, however, to each others' moods and expectations and very impressed by their own recent experience. So, taking their cues from each other, they overdo it, both on the upturn and the downturn.

In Forrester's model the long wave period is fifty to sixty years because of

the combined delays of capital build-up and depreciation in both the consumer-goods and capital sectors, with the added delay of capital self-ordering. The linked economy is a complex, ponderous Slinky.

### Technology Waves, Financial Panics, Political Upeavals

Forrester's is not the only long wave theory in circulation. Many of the others suppose, as Schumpeter's technology theory does, that the long wave is driven by some other cycle, which itself then has to be explained. What is most interesting about Forrester's theory is that it doesn't require another cycle to drive it. In fact, it explains those other cycles.

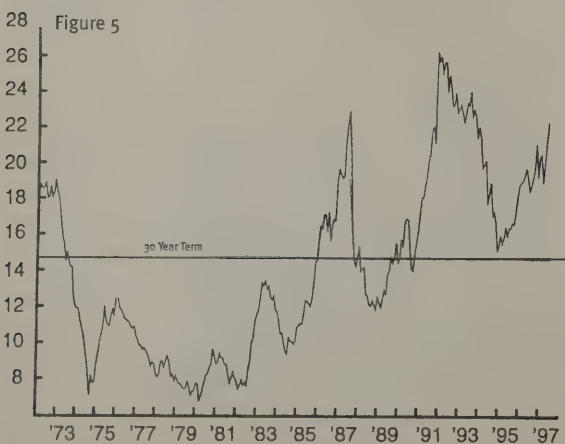
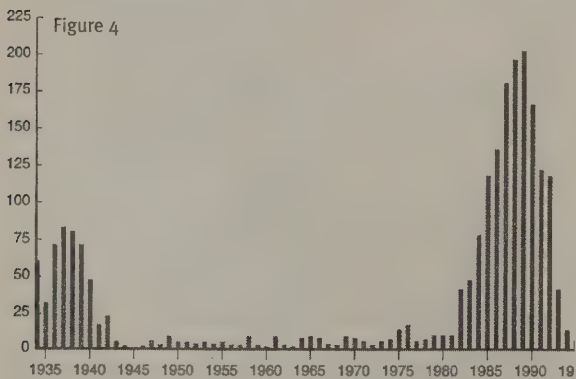
Technology gets implemented in cycles, says Forrester, because there is a window of opportunity at the beginning of each upturn. You don't build new car factories that use lightweight, crash-resistant, unrustable plastics when you're struggling to keep your existing metal-stamping plants running. You don't build combined-cycle gas power plants if you have coal-burners standing idle. You wait until the upswing demands a burst of new capital. Then you can build in new technologies. If they are cheaper and more effective than the old ones, they will enhance the upswing.

As the economy gets built back up, the window for major retooling closes. In a nation with a functioning, efficient rail network, entrepreneurs won't find it easy to start up an incompatible mode of transport. Thus, the Wright Brothers flew in 1903, but significant commercial air transport started with the DC-3 in 1935, after the depression had wiped out many railroads. The airline industry was only fully capitalized in the 1950s and 1960s (then overcapitalized in the 1970s and 1980s). During the long upswing, economic growth builds upon established technologies. New ideas get tested in small companies, many of which go broke, until the next upwave, when the best of those ideas can be literally cast into concrete or plastic or silicon chips.

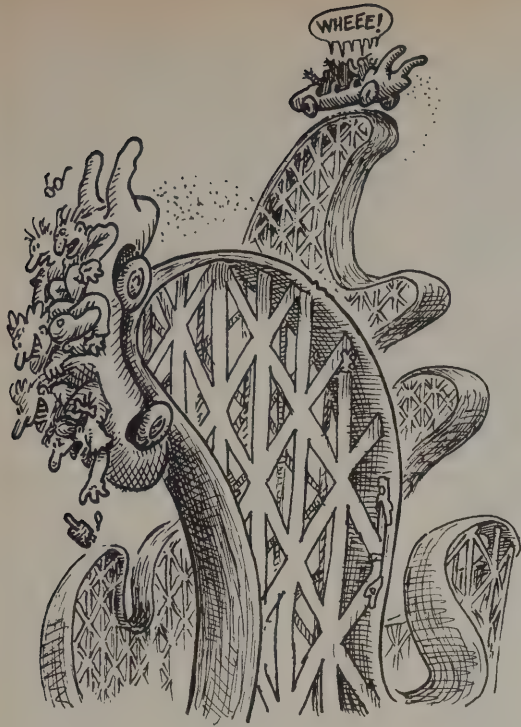
The seeds of technical revolution are planted during long wave troughs and bloom during upturns. Super-volatility in investment and banking is characteristic of peaks and downturns. The economy must shed excess capacity. It needs little new investment, compared to its voracious appetite during

Figure 4  
US bank failures, 1935-1995.

Figure 5  
Standard and Poor's price/earnings ratio (stock prices divided by earnings over the last year). Shaded areas are recessions.







financial cycles. Now why political cycles (Fig. 6)? During the long wave expansion, wages are rising, investments are paying off, material expectations are being met faster than people expect. There's enough satisfaction to be generous and enough optimism to consider all problems solvable, whether it's putting a man on the moon or extending civil rights to long-oppressed minorities or rebuilding war-torn Europe. The upturn is a time for progressive politics.

As the wave continues upward, and domestic production begins to catch up with domestic demand, businesses, followed closely by politicians, begin to look

beyond national borders. Trade expands, as companies scramble to find new markets. Competition gets cutthroat, because capacity is beginning to outstrip demand worldwide. Content analyst Robert Weber calls this the "cosmopolitan" phase. It can be characterized not only by great interest

in trade and foreign policy, but also by adventurism, imperialism, and conflict. In the early part of this century nations trying to make the world "safe" for their dominance set up the pressures that exploded in World War I. Fifty years later Cold War tensions drove dozens of smaller conflicts in Korea, Vietnam, Afghanistan, and elsewhere.

During the downturn, the most outmoded plants begin to shut down. People lose jobs or worry about losing jobs. Real wages fall, banks wobble, tax revenues drop, generosity dries up. The political agenda has less space for foreign adventure or domestic idealism. Faltering businesses and banks plead for deregulation. Struggling families want to hear about tax cuts. The underclass, hit hardest, may explode—leading to calls for law and order. It's a time when conservative thinking begins to make sense.

Robert Weber calls the bottom of the trough "parochial." That's a polite label. A more honest one might be "chaotic," or "panicked" or even "fascist." After fifteen to twenty years of downsliding, conservative policies lose their appeal. Tax breaks for the rich lead not to investment, but to resentment. Less public support throws even

the upturn. But there is an enormous pool of pension funds, endowments, private savings, and financial game-players eager to multiply money. With few real investment opportunities, the financial markets, with stunning creativity, think up unreal ones. They have to be newly invented at each long wave downturn, because most of the inventions of fifty years before have been outlawed.

In the 1920s, there were leveraged brokerage accounts, fictitious gold and oil stocks, Florida land booms, and trusts whose only assets were stock in other trusts. In the 1980s, there were junk bonds, derivatives, and leveraged buyouts. (If you can't expand in real terms, you can pretend to expand by buying other companies.) Both downturns saw speculative excess in real estate, art, and other assets. The more these bubbles were allowed to blow themselves up, the bigger the pop when it became obvious that money value far exceeded real value. Many pops have occurred in the past twenty years. There are probably more ahead (Figs. 4 and 5).

In the long wave trough, asset values finally depreciate to their real worth. Then they depreciate even more. After a time for everyone to sober up, it becomes clear that some assets are undervalued. The economy turns slowly into the next upturn, with so many sound investments to make that few investors will be attracted to unsound ones.

So much for technical cycles and

Figure 6



Figure 6  
Political values as predicted by long wave theory.



Figure 7  
Multiple behavior mode of cycles through time.

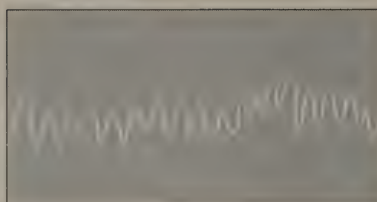
middle class folks onto their own diminished resources. The headlines are full of bank failures and foreclosures. Rough business competition can degenerate into rough personal competition; people begin to be out for themselves, uninterested in the public good. It's easy to lose faith in government, corporations, the rule of law, the whole society, the future. It's tempting to find someone to blame.

At this point, any assured voice is attractive, whatever that voice says. That makes the political situation unpredictable—it depends on what voice is loudest. In the 1930s, the loudest voice in the US happened to be that of Franklin Roosevelt, who preached optimism, compassion, mutual belt-tightening, and government activism in creating jobs and providing basic needs. In Europe, the loudest voices belonged to Hitler and Mussolini, who offered rigid control, trains that ran on time, national pride, militarism, and in the case of Hitler, industrial-scale genocide.

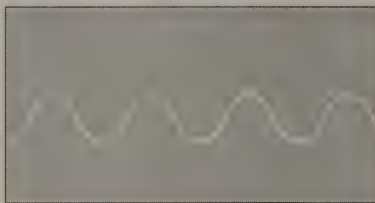
In the 1990s in America, with Democratic agendas looking like Republican agendas of the 1950s and Republican agendas edging toward repression, Rush Limbaugh and Newt Gingrich were the most certain-sounding voices for awhile. They had—and have—many adherents. But they came a bit too late in the cycle; facts are debunking their policies. Bill Clinton is unsatisfying, not because his ideas are wrong for the time (some are appropriate) but because he sounds so wavery. He's in power mainly because he has been blessed with even less substantial opponents.

At this point, in the late '90s, at the trough of the cycle, opportunities for leadership—even for humane, whole-system, forward-looking leadership—are wide open.

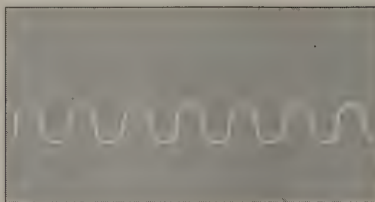
Random Noise



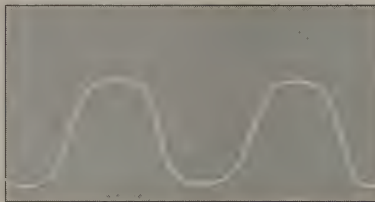
Business Cycle. 7 Years



Construction Cycle. 5 Years



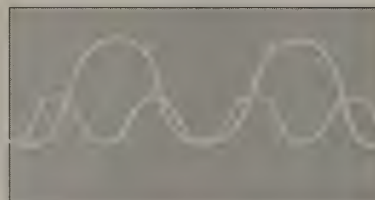
Long Wave. 55 Years



Growth. 200 Years



Business Cycle and Long Wave



The downturn of the 1930s was sudden, steep, and imprinted indelibly in memory and history. The depression of the 1880s and 1890s was undramatic, more like the slow, discouraging slide we are experiencing a century later. There are too many sources of variation, there is too much complexity, learning, institutional change, and social evolution for cycles to repeat themselves exactly.

The long wave is also hard to perceive because it isn't the only thing that's going on. Several different dynamics are working simultaneously (Fig. 7). There is short-term noise, caused by the normal socioeconomic hiccups. There are four-to-seven-year business cycles, eighteen-to-twenty-five-year construction cycles (called Kuznets cycles), and the fifty-to-sixty-year long wave. Finally there is the 200-year upthrust of the industrial revolution, propelled by population growth, capital investment, and technical advance, which will continue to raise all boats until it runs into social or environmental limits.

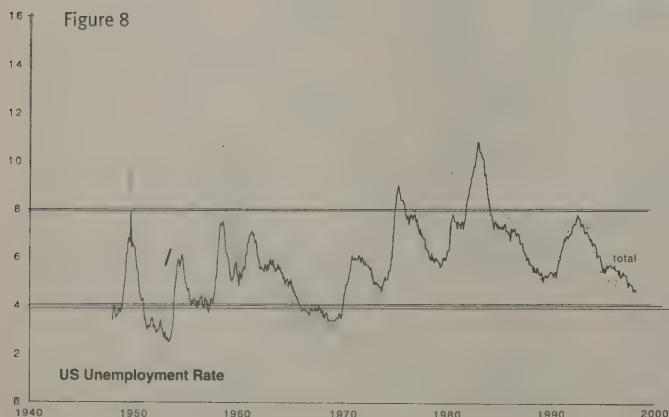
Consider for a moment just two of these dynamics, the business cycle superimposed upon the long wave. During the long wave upturn, recessions tend to be gentle. They make short interruptions in long, satisfying booms. These are the times when economists start talking about having recession under control and politicians begin to think they have mastered economics.

During downturns, however, the picture reverses. Long, deep recessions alternate with "weak recoveries," "structural adjustments," "recovering profits without job growth." Since we traditionally blame economic events on politicians, during downturns we begin to think of our leaders as bozos. This can be a period of rapid shifts in power, as voters discover that no party knows what to do about the worsening economy.

To see how hard it is to untangle the signals from the noise, consider the last fifty years of US unemployment rates (Fig. 8).

You can see the blips of noise in this graph, and the four-to-seven-year business cycle troughs (unemployment peaks). You might also make out two twenty-five-year Kuznets cycles (driven mostly by delays in the construction industry). The long-wave downturn is visible in the three increasingly worse

Figure 8  
US unemployment. Solid line is overall unemployment; dotted line is unemployment in manufacturing.



### Why Liberal Policies Sometimes Work, Conservative Policies Sometimes Work, and Politicians Never Learn

The long wave has been operating since the industrial revolution began, but it hasn't penetrated our understanding. One reason for that is that technical and social changes over the course of a single cycle ensure that no upturn, downturn, peak, or trough is exactly like the one before.



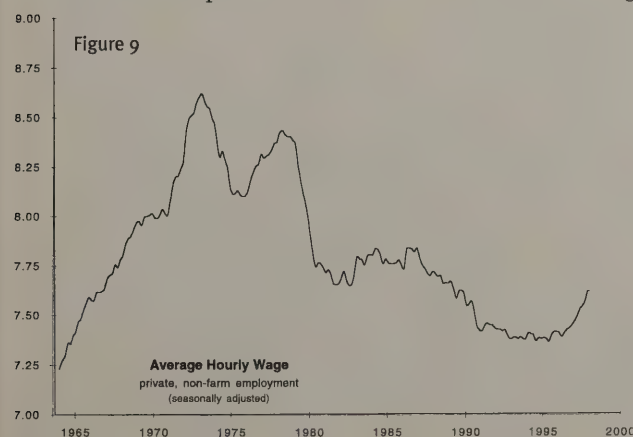
recessions of the 1970s and 1980s, each one ending in a “recovery” with a higher unemployment rate than the one before. The way we keep unemployment statistics (defining the hopeless out of the labor pool, not distinguishing permanent from temporary jobs or high-paying ones from low-paying ones) hides much of the evidence for the long wave, however. It becomes more apparent when you look not at unemployment but at real wages (Fig. 9).

A final reason for non-understanding of the long wave is that a fifty-sixty-year cycle is incompatible with human learning. Those who might have absorbed the lessons of one downturn (or upturn) are just about off the scene when the next one shows up. Those in power at any time formed their professional experience during the phase of the long wave that least resembles the phase they are negotiating. So we have people whose learning is out of phase with present events, trying to cope with a complex system that is undergoing many kinds of ups and down, some of which offset each other, some of which reinforce each other.

Let us pause for a moment of commiseration for the politicians who have to pretend to control this system, and for the rest of us who have to make a living within it.

The complexities of economic dynamics can be eased by pretending that they are simpler than they are—by cleaving to a liberal or conservative ideology. Both these ideologies persist because they contain important truths. Each is particularly applicable to one phase of the long wave. Unfortunately, because of the bad match between human generations and the timing of the wave, they tend to get applied with astonishing perversity at exactly the wrong times.

Consider the upturn. Production



capacity can't keep up with rising demand. Stunning new technologies are coming on line. Capital is urgently needed. This is a time to damp down consumption and encourage savings and investment. High consumption taxes and low investment taxes make sense. So does fiscal conservatism—government shouldn't be running deficits, competing with the private sector for scarce savings. Jobs are plentiful; anyone who can't find one probably needs to be given a kick. If there was ever a time to shift the tax burden away from the rich and onto the consuming masses, a time when the idea of trickle-down has validity, this is it.

During the downturn, however, promoting investment is about as effective as pushing on a wet noodle. There is too much capacity, there can be no recovery until the economy discards the excess. What needs to be pushed is consumption, to keep up faltering demand. The long wave trough is the time to ease the lot of the poor, tax away the uninvestable excess of the rich, and run deficits. It is also the time to impose strong regulations on businesses, which are sorely tempted under duress to abuse resources, scrap environmental precautions, beggar their workers, and engage in risky financial maneuvers.

Especially during the downturn people instinctively do the opposite of what is called for. Times are scary, businesses are failing, debts are mounting. It seems logical to reduce deficits, cut government spending, and try to keep shaky firms afloat by deregulating. Conditioned by decades of fighting the inflation inherent in the upturn, we keep money tight, though in the downturn the problem is deflation.

None of these policies produce the desired results, but ideologists are self-absorbed, self-righteous, and self-enforcing. Faced with failure, they just add another layer of denial and turn up the volume of rhetoric.

### What to Do About the Long Wave?

Forrester's model is just a theory. Economics is nothing but a bunch of theories. This particular

one—that a long wave exists and that it is caused by systematic, self-induced, economy-wide over- and under-investment—is never going to be popular. If there's anything people don't want to hear, it's that they are causing their own pain—or, worse, that they are being tossed around by the internal dynamics of an amorphous system that is not only impervious to human will, but that subtly conditions human will.

But this theory is as deserving of consideration as any other. Its hypothesized causal links are based on measurable elements of the physical economy. It has successfully predicted phenomena that have taken other theorists by surprise. Those of us who have watched its predictions play out for two decades now have no choice but to take the long wave model seriously, whether we like it or not. And its implications are not, in fact, so bad. If the long wave really does manifest from the linkages of a large-scale, complex, and deeply entrenched system, that does not mean that nothing can be done about it. The MIT analysis suggests ways to reduce the amplitude of its cycles and to mitigate the danger of the downturns.

Better information about the whole economy, collected by government and made available to all players, would help. Knowing, for example, how much electrical or steel or car-building capacity was on order economy-wide (which means, for steel and cars, world-wide) could sober the tendency to over-order as the long wave swings up, and ease the panic that causes too much downsizing as the wave swings down. Tracking, insofar as possible, the central long-term tendency of the economy, and the degree to which productive capacity has deviated from that tendency, could keep builders, lenders, and speculators from exacerbating the deviations.

The government could practice counter-cyclic policy. At the beginning of the upswing it could damp consumption and encourage investment; as the upswing threatens to go too far, it could do the opposite. Government could move against inflation on the rising wave and deflation on the falling wave. It could stand firm on regulations, especially on the downswing, when companies are tempted to cut corners and financial markets are tempted to lose prudence. It could strengthen the social safety net when it is most needed, even if that means

Figure 9  
US average  
hourly wage in  
1982 dollars.



deficit spending. It could repay debt and run insulating surpluses during upturns.

No government will have the discipline to do any of those things unless it deeply understands the economic structures that cause both the business cycle and the long wave. No democratic government will be allowed to do them unless the people understand as well. That means a massive job of public education, especially during the scary time of the downturn.

What is needed in the downturn, above all, is reassurance. The downward slide does not signal a disintegration of the social order. It is simply a correction for excess capital, first in the capital-producing heavy industries, later in the consumer-goods industries. The real wealth of the nation—land, resources, people, machines, know-how—is still there. It needs to be reorganized and restructured. Some businesses and workers can be hurt in the shift, if there is no social commitment to help them. If there is that commitment—if solidarity and generosity can be summoned—then not only will the political rhetoric be uplifting rather than nasty, but the trough will be less deep.

The good news about a long wave is that what goes down must come back up, at least as long as there's room on the planet for the exponential growth of the industrial revolution. (Some of us believe there's little or no room left, but that's another computer model.) In the coming upturn technical opportunities will blossom. The IBMs and Xeroxes of the future are forming now around, I hope, solar energy, nanotechnology, digital information transfer, radical energy efficiency, fuel cells, hydrogen fuel, zero-emission manufacturing and total materials recycling—all of which would help the limits problem too.

The most important thing to understand is that downturns are not one's fault. The hard times are not caused by Republicans, Democrats,

Indonesians, South Koreans, Japanese, immigrants, unwed mothers, overpaid CEOs, environmentalists, gays, feminists, Russians, Mexicans, investment bankers, Hillary Clinton, Rush Limbaugh, the Bureau of Alcohol,

Tobacco, and Firearms, the National Rifle Association, NAFTA, GATT, the United Nations, El Niño, Comet Hale-Bopp or any other handy scapegoat. Most of us enjoyed the ride up. We can minimize the slide down by being compassionate with one another and by stepping back far enough to understand, accept, and counterbalance intelligently the ups and downs of the market system.

### So Where Are We Now?<sup>1</sup>

I started by saying these long-wave folks could predict, but they don't do it with precise numbers by the week so you can use them to make a killing on the stock market. They predict important things, but they do it in broad sweeps, over decades.

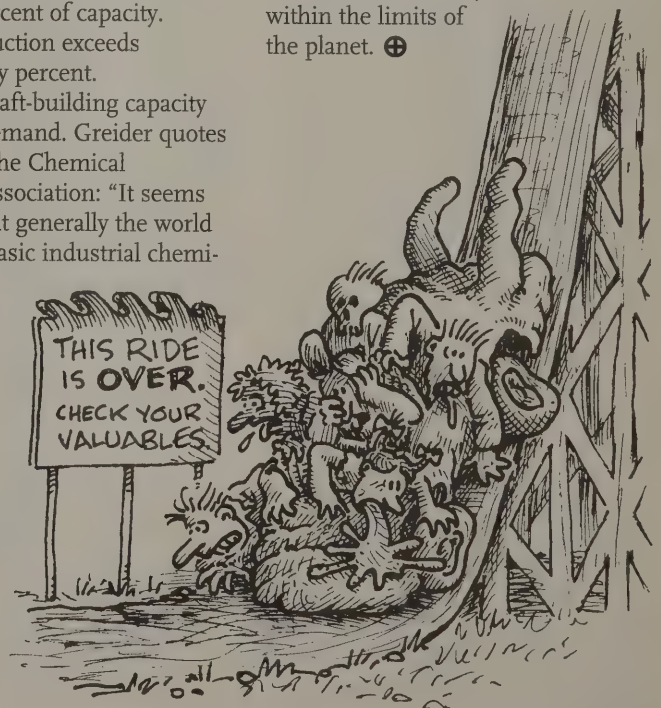
Most of them would say now that we're right at the bottom of the trough, though perhaps riding high on a short-term business cycle. The US, having shed much of its capital-producing capital over the past twenty years (one-third of its steel production, huge chunks of its machine-tool industry), may be about to turn upward. But we may be delayed by the linked world economy, which still has significant retracting to do.

According to William Greider's new book, *One World, Ready or Not*, worldwide car-building capacity was twenty-five percent over demand in 1985, thirty percent over demand in 1995, and is projected to be thirty-six percent over demand in 2000. The global tire industry in 1994 was operating at seventy percent of capacity. World steel production exceeds demand by twenty percent. Commercial aircraft-building capacity is *twice* market demand. Greider quotes an economist at the Chemical Manufacturers Association: "It seems safe to predict that generally the world supply of many basic industrial chemicals will trend toward an over-supply situation during much

of the rest of the decade and perhaps beyond." A research head at Roche pharmaceuticals: "Global prescription sales would need to reach about \$280 billion a year within ten years [more than twice the current sales] to justify the present levels of investment. The chances of reaching that figure are more than low—they are non-existent." A Sony executive: "Consumer electronics suffers from overcapacity, but that's why we are living in an interesting world." A former IBM strategic planner: "I've been worried for a long time that there's too much capacity, and as a result, there are very few people in the computer industry making much money. It's true in other industries too."

Asia was probably the main reason why this particular long wave downturn was more gradual than the last one. Asia provided a great sponge to soak up investment that had few other places to go. But now significant parts of Asia are themselves overbuilt. Card-houses are tumbling down. There could yet be a spectacular implosion, if overvalued financial assets come back down to earth quickly.

If no implosion, if we've managed by now to let off most of the steam of the overpressured economy, relatively unscathed by panic and totalitarianism (compared to last time, anyway), there ought to be an upturn sometime within the next ten years. It's an important one. It's the one we get to use to build the technologies and institutions and attitudes and understandings that will let us live sustainably within the limits of the planet. ⊕



1. This section provoked much argument. But, isn't US unemployment at its lowest, with real wages growing? How can this be the bottom? Russia, even Africa, seem to be climbing out of the bottom. Asia is down, but without upheavals. China is investing everywhere. The "extreme" view says that globalization and high-speed communications have undermined the Long Wave. Time will tell. —Ed.

For Donella's more official biography, see *Whole Earth* No. 91. She writes, "As for me, I put my faith in good topsoil and big trees and clean-running streams and mutually supportive human communities and honest work that provides people with what they really need."



## Betrayal of Science and Reason How Anti-Environmental Rhetoric Threatens Our Future

Paul R. Ehrlich and Anne H. Ehrlich. 1996;  
335 pp. \$16.95. Island Press.

### EcoFables/EcoScience

Free. Center for Conservation Biology,  
Stanford University, Stanford, CA 94305,  
ecofable@stanford.edu.

Biopolitics has devolved into a half-minute of talking heads and who's-got-the-best-one-liner. Journalists with no training in environmental science can't judge and simply report everything as if it were a High Noon shootout between the two best gunmen. Hyperbole is rampant, no matter what the position. The academic "brownlash" has been smoking and politicians wave books from the Ivy League (when they support whatever they want) as if they were Bibles. Assertion overwhelms logic.

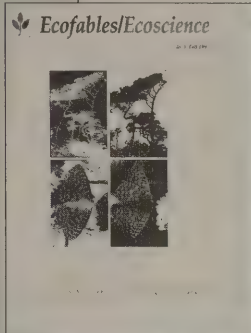
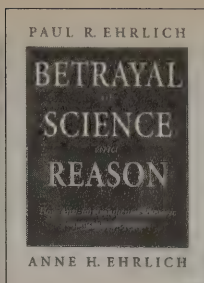
**Betrayal of Science** is a careful 335-page dissection (fable by fable) of how to

Later in the plenary meeting, when Santer presented the drafting group's revised text, the Saudi delegates once again objected. Santer forcefully challenged them. Why, he asked, had no Saudi attended the breakout group—if their objections had some basis in science? The head Saudi delegate haughtily announced

distort the (always tentative) conclusions of the environmental sciences. If you expect to be interviewed, **Betrayal** is a good way to bone up on the mindset of most reporters and the media. **EcoFables/EcoScience**, printed by the Center for Conservation Biology, is an occasional publication updating thoughts and events on distortions of environmental science, laced with outrageous quotes like that of Representative Richard Pombo (R-CA) blaming California's winter flooding on the Endangered Species Act, especially the "Elderberry Beetle (sic)." —PW

that he didn't have to account for his decisions about which drafting group to attend. Besides, he said, his was "only a small delegation" of a few people.

At this point the Kenyan delegate rose to speak. (I held my breath.) "I'm a member of a small delegation too," he said. (He was the only Kenyan delegate.) "But some-



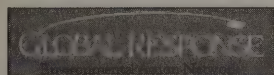
## The Clover. The Plover.

The Plover and the Clover can be told  
apart with ease,  
By paying close attention to the  
habits of the Bees,  
For ento-molo-gists aver, the Bee  
can be in Clover,  
While ety-molo-gists concur, there  
is no B in Plover.

how I managed to attend this most important drafting session. As a result, I am now convinced that [the section in dispute] is well written and I have no objections to its inclusion in the report." (I paraphrase his words from memory.) The impact of his intervention was stunning, stopping with a few words what appeared to be mounting movement of OPEC and LDC opposition...before it could gain any further support. —ECOFABLES/ECOSCIENCE

Woodcut from physicist Robert Wood's 1907 field-guide satire, *How to Tell the Birds from the Flowers*.

## Green Web Sources for Activists



### Global Response Network

No charge by email (donations encouraged), [globresponse@igc.apc.org](mailto:globresponse@igc.apc.org), \$25/yr dues for monthly GLOBAL RESPONSE ACTIONS by mail, PO Box 7490, Boulder, CO 80306, 303/444-0306, [www.globalresponse.org/](http://www.globalresponse.org/).

The emergency room mavens, full of moxie, shaming agencies and corporations into doing ethical acts. GR's monthly newsletter names names: specific people in corporations and governments to write—and points to make. They focus on environmentally destructive projects, protected areas, environmental racism, and indigenous people's rights. They have helped beleaguered NGOs from Burma to Birmingham. Its **Quick Response Network** sends email alerts about environmental activists who are being harassed, threatened, or attacked, with authorities to contact by letter, email, or fax. Special pro-

grams for high school and elementary school students.



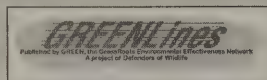
### World Wildlife Fund Conservation Action Network

No cost via email or website, [actionsignup@worldwildlife.org](mailto:actionsignup@worldwildlife.org), [takeaction.worldwildlife.org/about.htm](http://takeaction.worldwildlife.org/about.htm).

This new WWF program sends email action alerts (approximately once a month, more frequently when issues arise on short notice). Alerts suggest email or faxes to send to key decision-makers. Members respond by email to the **Action Network**, which forwards the messages to the targeted recipients.

### Greenlines

No cost on web ([www.defenders.org/gline-h.html](http://www.defenders.org/gline-h.html)) or by email: send message to [listproc@envirolink.org](mailto:listproc@envirolink.org). In body of message, write subscribe greenlines firstname lastname (your organiza-



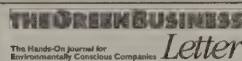
tion), \$20/quarterly by fax (505/277-5438).

GREEN (the GrassRoots Environmental Effectiveness Network), a project of Defenders of Wildlife, is the bull-and-bear DAILY news about public lands and wildlife issues and actions. The best scorecard on wins and losses in biopolitics. PW reads it daily. For information about ActGREEN, their restricted-access listserv for action alerts and legislative updates, email [rfeather@defenders.org](mailto:rfeather@defenders.org).

### Greenclips

Free email subscription: send email to [Greenclipsrequest@listserv.wsu.edu](mailto:Greenclipsrequest@listserv.wsu.edu). In body of message, write subscribe greenclips your email address; website: [solstice.crest.org/environment/greenclips/info.html](http://solstice.crest.org/environment/greenclips/info.html).

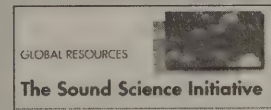
By email every two weeks, from environmental/architectural researcher and consultant Chris Hammer. News summary and digest of recent articles on green building design, law, resources, and related matters.



### The Green Business Letter's Ratings of Green Business Sites Free.

[www.greenbiz.com/webate.htm](http://www.greenbiz.com/webate.htm).

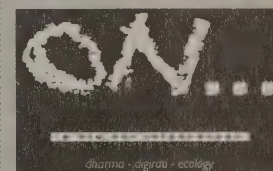
We reviewed Joel Makower's *Green Business Letter* (monthly; \$127/yr paper, \$95 electronic) in Issue 92. His GBL website rates and links with more than forty corporate, government, university, and other green business sites. Sites are awarded one to five spider webs: is it useful to environmental managers? good information? linked to other sites? easy to use? visually appealing? accessible?



### Sound Science Initiative

Started by the Union of Concerned Scientists, SSI

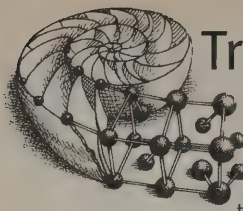
focuses on global issues: biodiversity, climate change, ozone, and population. Its 1,500 scientists use the information to combat "junk science" with the media, action alerts, feedback, and data. The web site gives concise and accurate summaries.



### On www.onweb.org.

An "infoscanner"/webzine on "memes relating to dharma, the digital juggernaut, and the Earth herself." Original and recycled writing (Allan Hunt Badiner on "Luddites with Websites," Mark Dowie on his hope to drive the word "sustainability" to extinction). Reviews of an eclectic mix of music, writing, and art, and links to the usual (and some unusual) suspects.





# Truth, Beauty & Mathematics

Michael Stone

I still remember a theorem I proved in 1962. Actually, I don't remember a thing about the theorem itself or how I proved it.

What I remember is a moment of pure, visceral, take-that, sunsets! beauty. One face of mathematics is truth *cum* beauty: symmetries, transformations, relations as unexpected and elegant as poems:

$$E = mc^2, A = \pi r^2, e^{\pi i} + 1 = 0.$$

Now the paradox: math also leads to truths so counterintuitive that they feel wrong even when proven. I *know* the odds are better than even that any group of twenty-three or more people will include at least two with the same birthday, but my

gut won't buy it. We struggle to penetrate what K.C. Cole calls "the veil that physiology and experience puts between knowledge and truth." From randomness to quantum mechanics, math takes us places where common sense won't venture.

The paradox is hardly new. "Rational" and "irrational" are, first, mathematical terms; legend says that the Pythagoreans tossed Hippasus from a boat for revealing that rational thinking leads straight to irrational numbers. Mathematicians bow to Reason, but embody the same quiriness, passion, and foibles as the rest of us. These books explore the paradox from both sides.

tury, the problem was not central for most serious mathematicians: the greatest thinkers since Fermat had failed, and it seemed a dead end, unconnected to fruitful lines of inquiry. When Andrew Wiles announced he had solved the problem in 1993, he shocked the mathematical world; virtually no one in the close-knit, talkative circle of top-level mathematicians even knew he had been working on it. As it turned out, his 100-page-long proof tied together most of the twentieth century's discoveries in number theory, while solving other problems on which decades of important work depended.

**Fermat's Enigma** and its companion NOVA program tell the story wonderfully. Singh explicates key mathematical concepts clearly, with clever examples. Since many of the greatest and strangest mathematicians, from Pythagoras on, are implicated, Singh tells their stories too. The book's depth complements the video's immediacy—the alternating wonder, joy, and frustration of Wiles and other mathematicians is palpable; they also giggle a lot when trying to explain abstruse concepts for a TV audience.

“In order not to arouse suspicion Wiles devised a cunning ploy that would throw his colleagues off the scent. During the 1980s he had been working on a major piece of research on a particular type of elliptic equation, which he was about to publish in its entirety, until the discoveries of Ribet and Frey made him change his mind. Wiles decided to publish his research bit by bit, releasing another minor paper every six months or so. This apparent productivity would convince his colleagues that he was still continuing with his usual research. For as long as he could maintain this charade, Wiles could continue working on his true obsession without revealing any of his breakthroughs.

## Fermat's Enigma The Epic Quest to Solve the World's Greatest Mathematical Problem

Simon Singh. 1997; 315 pp. \$23.  
Walker and Co.

### The Proof

60 minute video. \$30. WGBH  
Boston Video, PO Box 2284, South  
Burlington, VT 05407, 800/255-  
9424, www.wgbh.org.

The world's longest-running unsolved problem was easy enough to understand: "Prove that there are no whole number solutions for this equation:  $x^n + y^n = z^n$  for  $n$  greater than 2." Its formulator, Pierre de Fermat, left a famously provocative scribble, "I have a truly marvelous

demonstration of this proposition, which this margin is too narrow to contain." Fermat died nearly thirty years later, in 1665, without revealing his proof (assuming he had one).

Still unsolved by the late twentieth cen-

“Wiles describes his experience of doing mathematics in terms of a journey through a dark unexplored mansion. "One enters the first room of the mansion and it's dark. Completely dark. One stumbles around bumping into the furniture, but gradually you learn where each piece of furniture is. Finally, after six months or so, you find a light switch, you turn it on, and suddenly it's all illuminated. You can see exactly where you were. Then you move into the next room and spend another six months in the dark. So each of these breakthroughs, while sometimes they're momentous, sometimes over a period of a day or two, they are the culmination of, and couldn't exist without, the many months of stumbling in the dark that precede them.”

## The Universe and the Teacup The Mathematics of Truth and Beauty

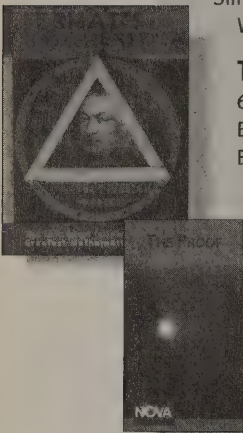
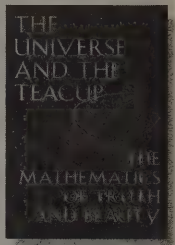
K.C. Cole. 1998; 214 pp. \$22. Harcourt, Brace & Company.

For a book devoted to math, **Universe** contains nary a number. If that's a sop to the math-phobic, I protest, but if she can convince people that it's safe—and pleasurable—to come out and play in the world of math, she'll serve math and society well.

Cole debugs intuition (a phrase from mathematician Amos Tversky). She catalogs the booby traps that our brains and intuition get us into. She helps us out with counterintuition, showing why, mathematically, the worst voting system is most-votes-rule; how be-nice-and-forgiving guys don't finish last, but win more often; or how ignoring probability feels good but leads to bad decisions. Not surprisingly, she prescribes a mathematics antidote for toxic thinking. Her writing is persuasive and poetic; in it, truth and beauty embrace.

“Our brains, it appears, may not be engineered to cope with extremely large or small numbers....If we can't readily grasp the real difference between a thousand, a million, a billion, a trillion, how can we rationally discuss budget priorities? We can't understand how tiny changes in survival rates can lead to extinction of species, how AIDS spread so quickly, or how small changes in interest rates can make prices soar....We haven't a clue how to judge increases in population, firepower of weapons, energy consumption.

Fortunately, scientists and mathematicians have come up with all manner of metaphors and tricks designed to give us a glimpse at those huge and tiny universes whose magnitudes seem quite beyond our comprehension....Geologist Raymond Jeanloz likes to impress his students with the power of large numbers by drawing a line designating zero on one end of the blackboard and another marking a trillion on the far side. Then he asks a volunteer to draw a line where a billion would fall. Most people put it about a third of the way between zero and a trillion. Actually, it falls very near the chalk line that marks the zero.

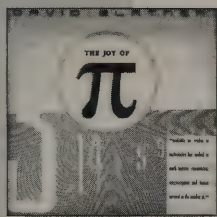




## The Joy of $\pi$

David Blatner. 1997; 144 pp. \$18. Walker and Co.

This one's for  $\pi$ -in-the-face fun. Blatner surely celebrates  $\pi$ 's importance, depth, and mystery. But his history of  $\pi$ -calculators is also a story of  $\pi$ -in-the-sky obsessives and their  $\pi$ -bald cousins like Hiroyuki Goto, who memorized  $\pi$  to 42,000 places. The book serves up slices of  $\pi$ , paeans to  $\pi$ ,  $\pi$  trivia (Albert Einstein was born on  $\pi$  Day, 3/14/1879; the height of an elephant from foot to shoulder =  $2 \times \pi \times$  the diameter of its foot). The first million digits of  $\pi$  run across pages and down margins, in type tiny enough to leave anyone  $\pi$ -eyed. If this isn't enough, the **Joy of  $\pi$**  website, [www.joyofpi.com](http://www.joyofpi.com), offers more, with links to clubs where the  $\pi$ -ous gather.



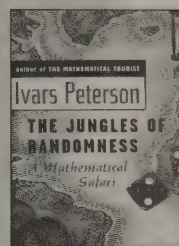
“Mathematicians throughout history have dedicated years of their lives to churning out as many digits as possible. The current record, over 51 billion digits, is a testament to the incredible power of both brain and computer. But why would people do this? No measurement realistically requires even 100 digits of  $\pi$ . In fact, even the most obsessive engineer would never need more than 7 digits of  $\pi$ , and a physicist wouldn't use more than 15 or 20. So why are these mathematicians so driven?”

“Calculating  $\pi$  is one of the hardest workouts with which you can challenge a computer; a single wrong digit can cause every subsequent number to be wrong. In fact, whenever individuals have attempted to break the world's record, they have uncovered deep underlying flaws in their hardware or software that would have been impossible to identify any other way.”

## The Jungles of Randomness A Mathematical Safari

Ivars Peterson. 1998; 239 pp. \$24.95. John Wiley and Sons.

This is a book about the discovery of randomness everywhere in everyday life. Poised between total randomness (chaos) and total order (death), humans find—or invent—meanings. Randomness threatens what Peterson calls the “rationalizing coincidence engines of our minds.” He hacks a path through quantum mechanics, drum vibrations, weather systems, stock prices, “miraculous” occurrences, athletes' hot streaks, and finds randomness where our minds might prefer reason and patterns. His gearbox includes tools to construct “oases of regularity,” like statistical analysis or check-digits on bar codes. Whether you choose to find all this optimistic or pessimistic depends on whether you focus on the jungle or the clearings.



## $e$ The Story of a Number

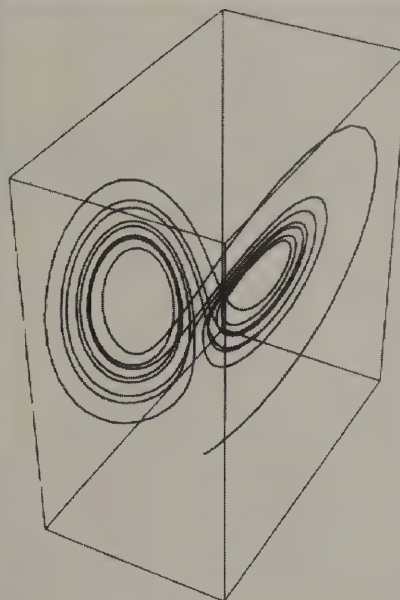
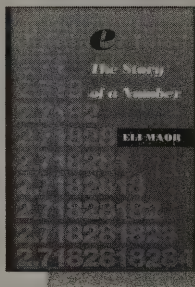
Eli Maor. 1998; 223 pp. \$14.95. Princeton University Press.

On the mathematicians' hit parade,  $e$  ranks up with its close relative  $\pi$ . Because it lives beyond where most people drop out of math, though, it hasn't gotten its public due. Maor remedies that.

Numerically,  $e = 2.718281828559045\dots$ . By definition,  $e =$  the limit of  $(1 + 1/n)^n$  as  $n$  approaches infinity. Not clear? Maor will make it clear.

The magic of  $e$  is its unifying such disparate realms as compound interest, radioactive decay, the shape of a hanging chain, “golden rectangles,” the mathematics of a sunflower, and the notes of Bach's

scale. To understand  $e$ , Maor recapitulates the evolution of logarithms, calculus, and transcendental numbers. These excursions aren't detours; they're some of the best parts of this journey, enlivened by the personalities, feuds, and follies of the thinkers who developed them. The math of  $e$  is the most challenging of the books reviewed here.



Edward Lorenz's butterfly attractor: a way of representing solutions of a set of equations that serve as a simple model of weather systems. Though the lines look solid, they actually consist of thousands of closely spaced points.



“[This equation] must surely rank among the most beautiful formulas in all of mathematics. Indeed...  $e^{\pi i} + 1 = 0$  connects the five most important constants of mathematics (and also the three most important mathematical operations—addition, multiplication, and exponentiation). These five constants symbolize the four major branches of classical mathematics: arithmetic, represented by 0 and 1; algebra, by  $i$ ; geometry, by  $\pi$ ; and analysis, by  $e$ .”



“There are fundamental limits to what we can know, what we can foretell, and how much we can understand of both the physical universe and the universe of mathematical experience. What we cannot attain we label as random, or unknowable. But perhaps randomness itself is a crucial unifying experience.”

“If something happens to only one in a million people per day and the population of the United States is 250 million, “you expect 250 amazing coincidences every day,” Diaconis says. Some fraction of these occurrences are bound to be reported somewhere in the press or remarked upon in the interminable discussions that take place on the Internet.”

Far left: The logarithmic spiral, a function of  $e$ , describes both the sunflower's pattern and relationship of the notes on an equal-tempered scale.



Whole Earth is a conversation. Compliments, cavils, and corrections are welcomed. Letters may be (reluctantly) edited for space. Write to 1408 Mission Avenue, San Rafael, CA 94901 or wer@well.com.

## The Cross-Generational Science of Wicking

In February Whole Earth received this letter...

I am ten years old and doing my science project on surface tension of water. I added various solutions to water and then placed two cups side by side—one with the liquid and one empty. I then “wicked” a strip of linen fabric (last year’s project was which fabric absorbed and wicked best) in the solution and placed it over the edge of the glass. I used water as my base.

The solutions that beat water were salt water, vinegar, wine, and Diet Coke. Can you help me understand why this is so?? Thank you.

—Aubrey Stark, 4th grade, Carrollton, Texas

PS: Liquid soap, lime juice, lemon juice, Karo, and vegetable oil were my worst solutions.

We asked Steven Vogel, the author of *Life’s Devices*, for his thoughts...

Interesting business, the linen-strip siphon! But I must confess to being a bit mystified by the specific results. I’d guess that surface tension isn’t the only physical agency at work. Perhaps I ought to duck behind (or use as an excuse) my professional status as biologist rather than physical scientist and refer you to someone with real experience and expertise.

Might I thus suggest forwarding the inquiry to Professor Emeritus Lloyd Trefethen, of the College of Engineering at Tufts University. He has both written about surface tension and made movies illustrating how it works.

As a colleague of mine once said, “You may have inner tranquillity, but you can’t escape surface tension.”

—Steven Vogel

Let’s try the retired professor...

Miss Aubrey Stark’s wicking experiments with linen strips was a bit surprising since I had never wondered about the influence of surface tension on wicking rates. Viscosity is what one would usually think of. But viscosity would not seem to explain Miss Stark’s observations.

In a wetted porous material, like a hanging strip of linen wet with water, the water surfaces pull on the fabric and to some extent compress the channels within the fabric, reducing the flow area. So a very high surface tension could reduce the flow rate.

But a very low surface tension would do the same, in a different way. The suction pressure in the siphon would pull the liquid/air interfaces into the channels in the fabric, and reduce the flow area.

So, if both a very high and a very low surface tension would reduce the flow rate, there must be an in-between surface tension value that would provide the maximum flow rate for a particular fabric strip. This is, to me, a new and interesting idea.

Some questions: Were both ends of the strip under water? Roughly what were the volumes of additives to the volume of water? Roughly how much difference did they make in the flow?

—Lloyd Trefethen

We waited several weeks for Aubrey’s response...

From:soccermom@momcare.com  
Subject: Wicking experiment

This is Aubrey’s mom and I’m afraid I have been remiss in getting Aubrey to get the information to you. I will have her sit down and do it tomorrow. I’m sorry—we got missing in soccer and softball season among three kids and just didn’t get back to Mr. Trefethen. We will though.

Terri Stark



Aubrey’s report, “The Race is On!!” arrived by mail...

Race Results: Salt water immediately took the lead, with Diet Coke in second. At the fifteen-hour mark, Diet Coke burst forward and passed salt water and crossed the finish line by twenty-one hours.

At the twenty-nine-hour mark, wine and vinegar had a sudden spurt and beat salt water out for the second and third place finishes.

By forty hours, salt water did finally cross the finish line along with water which was our control solution.

For those that never did cross the finish line: hot water and baking soda solution got close but never quite made it over. Lemon juice made it about half of the way while liquid soap didn’t even make it to the half-way point. Never quite in the running were vegetable oil and Karo because they were both much thicker than the other solutions in the race.

Conclusion: My hypothesis is rejected because two of the solutions, lemon juice and Karo, that I had predicted would move from one glass to the other due to surface tension and capillary action did not. While salt water, which I predicted would not move because I thought the salt would weaken the water’s surface tension, actually lead the race until the very end.



The professor examines the results...

Miss Stark raises questions in my mind that I had not heard before.

Let's take one of her results and try to understand it. Salt water "wicks" better than water.

Salt is one of the few solvents that increases the surface tension of water, but only by about four or five percent. But will a small increase in surface tension lead to more wicking flow? A good question, and one that doesn't have a simple answer.

If surface tension were zero, there would be no wicking, and no flow. If surface tension were infinite, it would compress the wick infinitely, closing all open channels, therefore no flow. So, somewhere in between there is a surface tension for a given fabric that would give a maximum flow, dependent on the flexibility and the compressibility of the wick material.

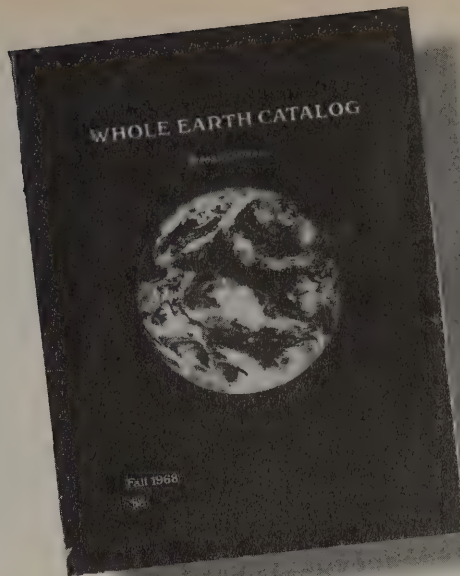
So what did Aubrey explore? Surface tension? Viscosity? Fabric compressibility? Fabric chemical engorgement? A great question, one on which I would hope others will follow up. I suspect that this is a relatively unexplored topic.

Two somewhat similar topics that are rather well understood and do involve surface tension directly are candle wicks, and the raising of sap in trees.

Sap in tiny holes in leaves is evaporated by heat from the sun, and surface tension provides the suction pressure needed for replenishment sap from the roots. But the tree provides rigid channels for the sap, which a candle wick does not. A candle wick sucks up molten wax which is then evaporated by the heat of the flame into a vapor that burns and melts the wax to maintain the pool of molten wax. Designing a candle or a tree for a desired evaporation rate would not be an easy engineering project.

The answer may involve factors other than surface tension and viscosity, such as the compressibility of the linen wicks, and of course possible swelling effects caused by the chemicals. Miss Stark's question is complex, and should be further studied.

— Lloyd Trefethen



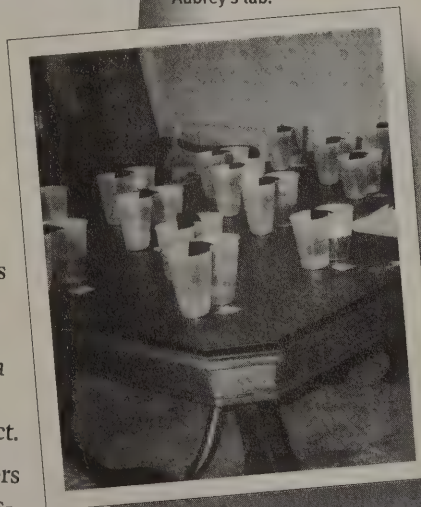
### Attention!

This is the thirtieth anniversary of the first Whole Earth Catalog. We're looking for funds to reprint the 1968 edition. We also want to know what lasts. Send us the names of books or tools from Whole Earth's first thirty years that remain most active in your minds and hearts. First thoughts, best thoughts. Then take a leisurely walk and palaver with a friend.

Send your thoughts to:

Whole Earth Magazine, 1408 Mission Ave.,  
San Rafael, CA 94901  
wer@well.com, fax 415/256-2808

Aubrey's lab.



### Soul y Cashola

At last, Whole Earth has produced a thorough issue on economics, money, and social responsibility [Spring 1998]. Bravo!

I hope future issues address systemic reforms—beyond the laissez-faire views of Richard O'Brien and including the financial reforms discussed in the report of our Global Commission, which focus on defending the global commons from commercial exploitation.

Hazel Henderson  
Saint Augustine, Florida

Here at Co-op America, we really loved your Spring issue of Whole Earth. I want to let you know how honored we were to be included. Your holistic approach to the subject of money as well as your combination of serious and tongue-in-cheek writing makes for a truly refreshing and thought-provoking issue.

I was especially happy to see democracy, equity, local self-reliance, and ecology included as topics. Thank you so much for giving your readers so much important and timely information to ponder. The process and style of Whole Earth is

And so we put it to you,  
gentle readers...





wonderful. Every time I pick it up, I find an intriguing new angle that sends me on a path of discovery.

Thanks again. It was a pleasure working with you on this and I hope we will be able to help each other again in the future.

Alisa Gravitz  
Washington, DC

### Pocket Preservations

Thanks much for the most recent issue of *Whole Earth*, it arrived on exactly the right day—i.e. yesterday, because a few hours later I went to a slide show/meet, the group sort of evening organised by Australian Bush Heritage Fund, the first such meeting they've ever had in Canberra I think, so it was a pretty good coincidence.

ABHF is based in Tasmania and coordinates the same sort of buying environmentally—much-worth-preserving pockets of land as was described in your article on page 65 ["Buying Back Eden," No. 92]. So I took it along and they were much pleased and took a photocopy of it. They may be in touch directly—I gave them your email address.

Stephen Hodgkin  
Lyneham, Australia

### How Life Works

I am very interested by *Whole Earth*, but I have not subscribed or given a donation, or written on a disk. This is not my will; it is how the shilling is going. Your books have opened many doors in my mind. Now I have started to know the Earth well. I can say many thanks to you because I was living in darkness. I was very happy with the cover of No. 90, Summer 1997. I'd like to know more about the following: NASA stations, fractals, how life works, chaos, botanical technology, more about nature. With your books I am a different man.

John Mwangi Githu  
Kiria-ini Murang'a, Kenya

### Organic Agriculture

Dan Imhoff did a fine job in laying out the case for a long-term organic farming strategy ("Organic Incorporated," Spring 1998, No. 92). However, a few inaccuracies need to be corrected.

1. It's not true that "Weber...drained the land" on the parcel in question. The historic ditches on the seasonal wetland



parcel carry water from a higher elevation into the wetland area, where the water (and its

sediment) is held back by dikes and slowly released to the Bolinas Lagoon.

2. It's not true that "lawsuits erupted." There are none.

3. The (endangered) black rail. It has never been demonstrated that the habitat in our area will support black rail. The hundreds of acres surrounding our farm do not at this time. Yet the field in question that we work every summer is a incontrovertibly successful winter wetland for dozens of species and thousands of shorebirds, ducks, and geese and in this respect superior to the public property next to it at the same elevation. Some ecologists—and I think most citizens—see the beneficial relationship between good farming and good stewardship. Contrary to the manner in which my comments were portrayed in the article, we at Star Route Farms are proud of our stewardship of the farm's natural resources and welcome the input of good science to our practices.

4. In no way would I countenance the author's suggestion of using the name of an endangered species as a commodity label. I find that idea banal at best.

Warren Weber  
Bolinas, California

*Editor Peter Warshall replies:*

I want to personally apologize to Warren Weber. There are no lawsuits, no court hearings, and no threats of lawsuits. My confusion (relayed to the article's author, Dan Imhoff) came from a misunderstood comment about alleged conversion of wetlands and construction of various tidal gates, ditches, and dikes in violation of the Clean Water Act. The Army Corps and Warren are working out their differences. I misunderstood Warren's hiring of a lawyer to talk with the Army Corps as indication of a lawsuit.

According to reliable birders, black rails have been heard within 100 yards of Star Route Farms. No breeding pairs have been

seen. The Endangered Species Act gets sticky in these circumstances. How can a biologist or an agency determine which habitat is suitable for future recovery of a rare species, a goal mandated by the ESA? Reconciliation of private property rights, partial information, and the preservation of habitat for the future recovery of sensitive species like the black rail or the San Francisco yellow-throat has no clear path. This difficult dialog ripples throughout the United States.

*Author Dan Imhoff replies:*

It was not my intention to draw your commitment to stewardship into question. I consider you an exemplary farmer and interpreted your willingness to search for ways to more fully integrate ecological principles into Star Route Farms as a continued example of your leadership in the organic movement. While using an endangered species to promote future farming practices might seem to you a crass suggestion, I do believe customers will increasingly value knowing about the extra care farmers take in the cultivation of produce, whether in the preservation of species and threatened habitat, or the just treatment of farm laborers. I have clarified my text for any future reprints of the article.

### Who Loves Ya, Baby!

When recently telling a reporter the story of the growth of my business, Lerner Seeds, I realized that the inclusion of my business in the *Whole Earth Catalog* twenty years ago basically made the whole thing happen. Like many, I am gratified that *Whole Earth* has risen again. Thanks very much for making a recent ride up 101 most enjoyable through your participation in a radio talk show.

Judith Lerner Lowry  
Bolinas, California

### Are We Not All Udder Carp?

I am sorry but I am sorrily unimpressed with the hackneyed, jaded writing in your magazine. I am particularly wondering why anyone would call the Lindisfarne Association "a mental mafia." Are we not in this all together? Or should we continually splice hairs of self-righteousness? Your magazine borders on hipness, which is to say, fad consumerism and the culture thereof; I am not concerned with Image, but with truth. Your magazine is a divisive indecisive fragmentary vision of the world that should and will be mere sophistry and utter crap.

Thanks, but no thanks.

John Baler  
Skokie, Illinois

No complaints from Lindisfarne. *American Heritage Dictionary*: "mafia...3. informal. A tightly knit group of trusted associates." —Ed.



## Thanks

Whole Earth is grateful to these people who have provided editorial assistance; illustration and permissions procurement; and business, fundraising, and circulation help on this issue:

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Dave DeSante (Institute for Bird Populations)  
Barbara Deutsch (butterfly maven)  
Chris Desser (Migratory Species Project)  
Steve Eisenhauer (American Kitefliers Association)  
Andrew Fahlund (Hydropower Reform Coalition)  
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Pliny Fisk (Center for Maximum Potential Building Systems)  
Steve Gatewood (The Wildlands Project)  
Luke Giles (Coastal Conservation Foundation)  
Maya Goreau (Global Coral Reef Alliance)  
Tom Goreau (Global Coral Reef Alliance)  
Valerie Govig (*KiteLines* Magazine)  
Diana Hadley (hot mama)  
Laurel Higgins (beaver advocate)  
Wolf Hilbertz (Global Coral Reef Alliance)  
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Corey Jensen (kite buckaroo)  
Jody Joy (The Canadian Nature Federation)  
Dick Kamp (Border Ecology Project)

Mari Kane (*HempWorld*)  
Jim Kennedy (Bat Conservation International)  
Alfred Leick (University of Maine)  
Harilaos Lessios (Smithsonian Tropical Research Institute)  
Robert Long (Greater Laurentian Wildlands Project)  
Holly Lucas (The Collective Heritage Institute)  
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Hugh McIsaac (Boise State University)  
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Mia Monroe (The Monarch Program)  
Chris Newton (fisheries consultant)  
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Denise O'Brien (BHP Petroleum)  
Brian Peck (wildlife conservation consultant)  
Juri Prepee (Yukon Wildlands Project)  
DeeVon Quirolo (Reef Relief)  
Andy Robinson (Wildlands Project)  
Bart Robinson (Yellowstone to Yukon)  
Ilene Rosoff (*WomanSource Catalog*)  
Bob Small (La Cruz Habitat Protection Project)  
Bob Stewart (naturalist)  
Cindy Taft (Sea Turtle Survival League)  
Eric Tamm (Coastal Community Network)  
Chip Taylor (Monarch Watch)  
Julie Thompson (United Nations Department of Public Information)  
Charles Walcott (Cornell Laboratory of Ornithology)  
Wendy Weir (Coral Forest)  
Carlos Wesley (Coral Reef Alliance)  
Luisa Wilcox (Yellowstone to Yukon)

Thanks also to Gretchen Daily, Paul Ehrlich, the Arizona Game and Fish Department, and Carol Johnston for the use of their art work.

the text says. 'Pelew' is an 18th century corruption of 'Beluu ra Belau,' Palauan for 'Land of Belau.'"

The authors of *Getting a Life* (Whole Earth No. 92, p. 83) are Jacque Blix and David Heitmiller.

The current access for Turtle Island (Whole Earth No. 91, p. 52) is 4035 Ryan Road, Blue Mounds, WI 53517, 608/767-3931, fax 608/767-3932, beabriggs@aol.com.

## Updates

We failed to give Joe Franke credit for "Phra Pachak, A Monk Who Ordained Trees," and the accompanying illustration, in Whole Earth No. 91 (p. 40). We apologize. We are also grateful to Joe for updating his 1995 story:

"Seven charges were brought against Prachak Pethsing (known as Phra Prachak Khuttajitto), including the absurd charge of 'destroying the forest.' Out of exhaustion and fear for his own safety and that of those around him, he decided to disrobe [to return to the status of lay person] in 1994. Four years later, two of the seven charges are still being tried; he has had to go to court more than 50 times in the last two years. Life for Prachak Pethsing has become very difficult. According to his son, Prachak lives currently at a temple in Lopburi, north of Bangkok. He has again taken the ten precepts and again wears the white robes of the initiate. Prachak plans to be ordained again after the outcome of his court cases.

"In October, 1997, Prachak received the Honorary Award from Sarvodaya Foundation from Sri Lanka, given annually to an outstanding Buddhist activist. He was also recently portrayed by the German Greenpeace Magazine as a victim of 'State Terrorism against Environmentalists.' Prachak urgently needs material support to cover the expenses for his legal struggle. We would highly appreciate your support for him, through First Nations Health Project, Inc. (earmark checks in bottom corner as "Prachak Defense Fund"), 7435 SW 31st Avenue, Portland OR 97219. All donations made through FNHP are tax-deductible."

We had no Islamic environmental groups to list in Whole Earth No. 91. We have now received word of the establishment of the Islamic Foundation for Ecology and Environmental Sciences, PO Box 5051, Birmingham B20 3RZ England, phone/fax (021) 523-4264.

We have also just received *Ecology @ the Jewish Spirit (Where Nature & the Sacred Meet)*, by Ellen Bernstein (1998; \$23.95, \$27.45 postpaid, Jewish Lights Publishing, PO Box 237, Sunset Farm Offices, Route 4, Woodstock, VT 05091, 802/457-4000, fax 802/457-4004).

Volume II of *CSA Farm Network* is now available: Steve Gilman, Ruckytucks Farm, 130 Ruckytucks Road, Stillwater, NY 12170.

James Boyk, author of *To Hear Ourselves As Others Hear Us* (Whole Earth No. 91, p. 75) has started an online forum on the book. See the book's website at [www.cco.caltech.edu/~boyk/HEAR.HTM](http://www.cco.caltech.edu/~boyk/HEAR.HTM).

George Mokray has, at least for the moment, discontinued publication of his "A List..." (Whole Earth No. 90, p. 41).

## Corrections

Timothy O'Hara of the University of Chicago noted the following misnomer: "On page 42 of your No. 92, Spring 1998 edition of the Whole Earth, the text accompanying the photograph of Yapese and their money contains an error. The island nation where the Yapese have traditionally quarried their unique coinage is 'Palau,' not 'Pelew' as



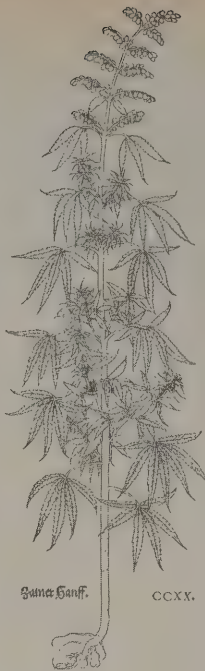


**L**ots of pro-hemp talk in the paper business. But have you ever seen it? Specialty papers or an occasional cover hype hemp. We wanted to see if it could break into the mainstream. Not since the early 1900s has a magazine's inside signature (cluster of pages) contained hemp-based paper. Whole Earth felt it was time to show you what it takes to change the fiber industry and what hard work it is to break into a market designed to keep you out.

Carolyn Moran runs Living Tree paper, a major American source of papers with alternative fibers. She helped us with our fiber issue (WE No. 90). We both yearned to print on alternative fiber paper, but mutual poverty prevented an arrangement. For this issue, Alex worked out an old-timey barter exchange, and we thank Living Tree for old-timey generosity between friends. Given the market, hemp fiber grown overseas (Hungary) is almost three times as costly as chlorine-processed tree pulp; grown in Canada, it is about twice as expensive as chlorine-processed tree pulp, and twenty percent more than recycled paper. Living Tree's donation is worth a good \$6,000, plus.

Our printer had the shakes about hemp for two good reasons: the US Post Office and printing on paper of different fibers. In Banta's recent past, a company selling shampoo with hemp oil wanted to paste in a little packet of the hemp seed used for the oils. The Rates and Classification Department of the US Post Office squashed that idea quick. When we announced our intention, Banta called the Chicago Rates and Classifications Department, which again said: Illegal! No matter how little THC or how good a fiber. So Alex called the San Francisco office and they said: Sure, go ahead, it's fine. Whole Earth called back and told the printer who called Chicago who backed off.

Living Tree's paper uses post-consumer waste, which is more to the point than recycled paper. Recycled is just the scraps from off the floor of the paper cutter. Post-consumer has been used, de-inked,



deconstructed and reconstructed. Each re-use breaks and shortens the fiber. Seven times around is about the limit. But adding hemp fibers gives post-consumer waste the strength it needs (so does kenaf). The cotton linter comes from the fibers left on the seeds. Usually too short for textiles, they make some of the best papers. The paper, as you can see, does not glitter and have the gloss of papers coated in clay or other coatings. This exposed, non-treated surface is the new aesthetic of less-processed papers. The printer needs to use less ink, allow longer drying time for each color, and use more offset powder to improve the drying process. We thank them for their willingness to give it a try.

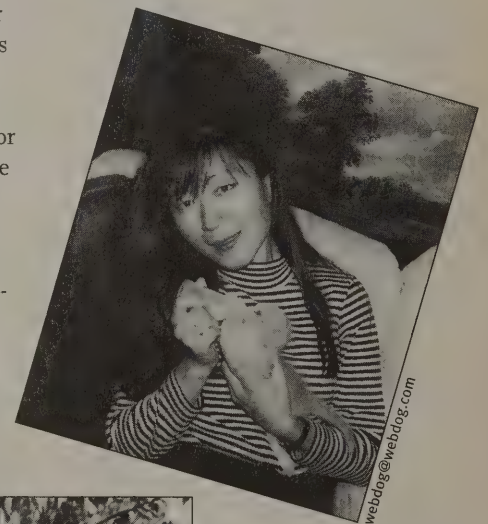
**Other gossip**

Great generosity, gifts from our readers, still keep us alive. We are secure for, at least, three more issues! For us, it's amazing, though realistically it's about as precarious as a magazine could be. We need more subscriptions and hope you'll give them as presents or find us a store that will help put Whole Earth on their newsstand. We've got some extra pages this issue through the generosity of a donor who wanted all of Donella Meadows's piece printed, without major cuts. We're probably the only magazine that gets paid to print great stuff.

Genuine sadness and happiness. Liz was accepted into Stanford and Northwestern graduate journalism programs. She decided on Northwestern 'cause it puts you out on the streets. Deadlines are overnight, not quarterly. We think she'll be teaching them, after her at-times grueling, sometimes

laughing time at Whole Earth. Liz weathered the death and rebirth, moving from intern to Assistant Editor, from Sausalito to San Rafael. She's a great moving van trucker, and she already writes long, graceful, and thoughtful sentences. We've been living in denial, hoping she'll change her mind. But now we search for a new Assistant Editor who loves dense content and struggling with Quark, and who can tolerate our inadequate wages.

Our Religions and Environment issue (with the vinesnake on the cover) was a success, except some people hate snakes so much they would not even pick up the issue. When Mike Stone tried to give them away at the Martin Luther King, Jr. celebration in Marin, a few individuals literally would not touch it. Boy, did I learn from that! We lost maybe ten percent on the newsstand (a pure speculation from wandering into stores). Tucson was the worst. Citizens there actually encounter rattlers, and it's in their blood to jump. Will it ever be possible to love the serpent in the garden of Eden? Not sleep with snakes, just count them in and give Noah's ark a chance. —PW



Left: Liz Thompson on the tractor at cherry harvest. Chorus and rescues orphan kittens menaced by earmites. Also, she has been writing a tragicomic opera—

working title: "Sledge & Veritas: Elephants at Magic Hour"—and hopes to wrap it up in the next year.



STANTON ORCHARDS



## Contributors' Guidelines

*Essentials:* Your name and contact information must be on the front page. We love Word disks or email but will take submissions in any legible form.

### Art and Longish Pieces

Payments for photographs, illustrations, articles, and other longish pieces are negotiated case by case.

*Submissions:* We'll send a noncommittal postcard when your manuscript has arrived. We don't return manuscripts unless you include a self-addressed stamped envelope. If we like it, we hang on to it, sometimes 'til two moons rise in the same dawn. We wait for the perfect circumstance, which sometimes doesn't arrive.

*Frontal queries:* Outline your proposed article in detail, 'cause we don't have the staff for long phone discussions. We pay on publication, and can't guarantee a piece will be used until we go to press with it. Sorry—no advance payments or kill fees.

*A few tips from the editor:* We like your personal voice: intimate, a lively conversation with an attentive friend, but not overly confessional or self-indulgent. We like ideas, thoughts, and events to appear to stand independent and clear of the narrator. Candor: speak right to our

ears, open, confiding everything from gossip to wisdom. A hard road to navigate. Don't inflate a short piece into a long one. Don't send us a variation on an old idea. Show us you did your homework. Don't rant against anything or anyone without very solid suggestions for fixing the rantee.

Be prepared to violate the above guidelines for elegance or to present a compelling point.

Don't be crushed at rejection. We reject our own submissions too.

### Reviews

We pay \$40 upon publication.

*Only great stuff:* We let bad, mediocre, wimpy, mushy, rehashed, and poorly crafted books and other items die their own deaths. Don't waste time and energy on items you only complain about.

*Why this item provides skillful means for mind, body, soul, community, or the planet.* First, ask yourself: Is this the only book or tool available for this purpose? If so, say so, especially if it's the first to offer a new idea, thought, or technique. Second, if other books or tools are already out there, and the new item makes no great difference, forget it. If it provides upgraded skillful means, a greater intimacy and sense of caring or wild/adventurous intellect, then make

sure the reader knows that you know how it compares with the other stuff. But avoid showing off your great and deep understandings or outlining the whole book. In one or two paragraphs, there's no room to explain.

*Beware the backcover blurb!* Write with an honesty that makes you squirm. Reveal your voice and all its slangish, idiomatic candor. Get out of the way of the book or tool.

*Let the excerpts speak.* They convey the thought or craft of writing. If you send us a disk, please type the excerpts, noting the page numbers. Or send photocopies with excerpts marked. Don't send us your personal copy of the book!

### Reprinting

Whole Earth buys all rights to reviews and first rights to articles. We reserve the option to reprint. If we do, we pay an additional amount. We allow small quantity reprints for nonprofit educational classroom or community use with no charge. If another trade publication asks to reprint your article, we refer them to you.

Send submissions to Whole Earth, 1408 Mission Avenue, San Rafael, CA 94901; fax 415/256-2808; email: wer@well.com.

Whole Earth relies on the generous support of its readers and foundations to make ends meet. Last issue we slipped and this box was not printed. We apologize profusely. We gratefully thank all those readers and friends who have given, at any level. (Phone Alex, ext. 225, to find out the "perks" offered at each giving level.) Particularly, the following people deserve special thanks:

#### Maniacals (\$1,000+)

Jaime Lubin Acosta  
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August  
Michael Lee Bailey  
Bambu Flyingwater  
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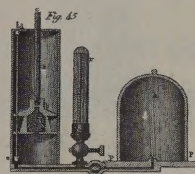
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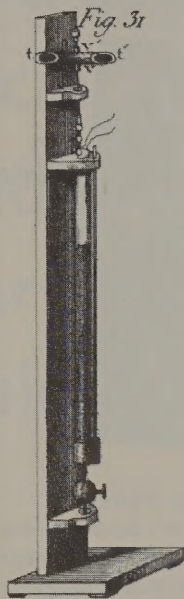
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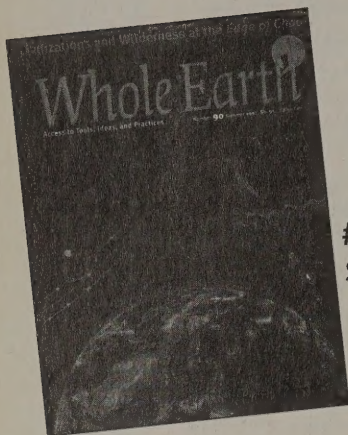
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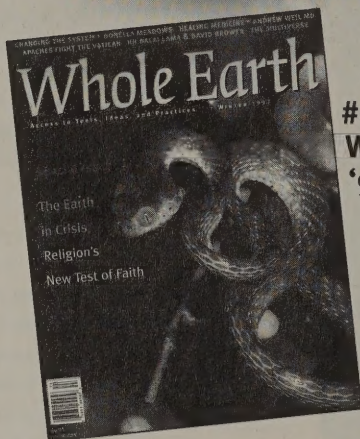
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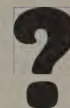
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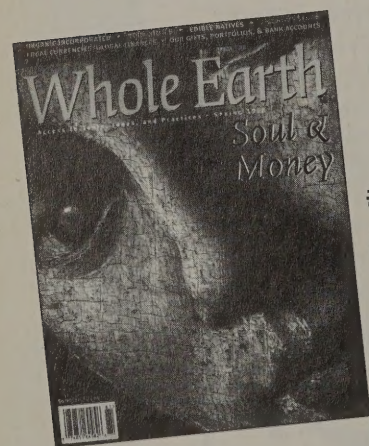


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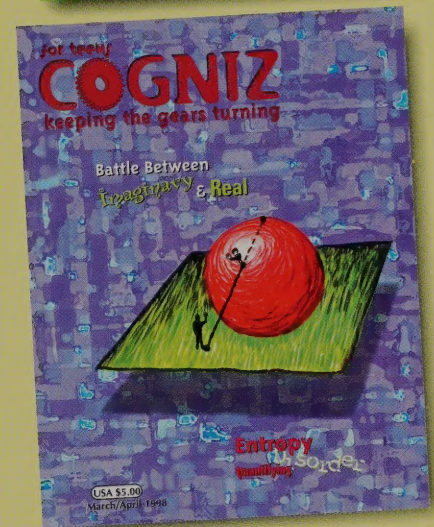
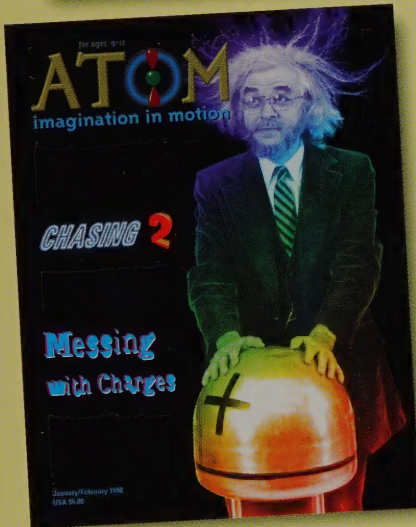
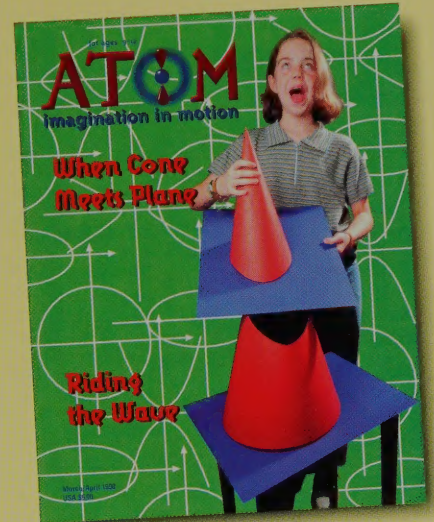
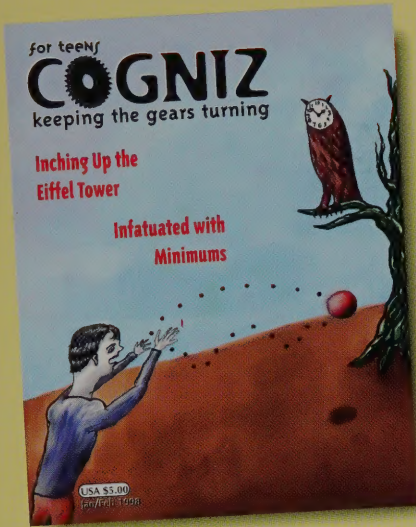
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
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